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2016-06-23
Dnr: S/Gbg-2016-82

Report from the SMHI monitoring cruise with R/V Aranda

Survey period: 2016-06-13 - 2016-06-20
Survey area: Skagerrak, Kattegat, the Sound and the Baltic Proper
Principal: Swedish Meteorological and Hydrological Institute, SMHI, and the Swedish Agency for Marine and Water Management, SWAM.

SUMMARY

The June expedition in the Swedish regular marine monitoring programme covered the Skagerrak, the Kattegat, the Sound and the Baltic Proper. This report is based on data that only have undergone a first quality control, when data is published at the data host some values might have changed after further quality controls have been performed.

All nutrient concentrations in the surface water were very low in the Skagerrak and the Kattegat. Stratifications was found at around 10 meters and nutrient concentrations increased below 20-30 meters. The inorganic nitrogen was depleted down to 30-40 meters but phosphate was still present in the southwest. The silicate levels were still above normal in the entire Baltic Proper.

Acute hypoxia was measured from around 70 meters in the entire Baltic Proper. Hydrogen sulphide was only present close to the bottom, 175-195 meters, at the Fårö Deep and from 80 meters in the Western Gotland Basin. The entire water column at the Gotland Deep was still oxygenated.

Next regular cruise is scheduled to start 18th of July.

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RESULTS

The expedition was conducted aboard the Finnish research Vessel Aranda. It started in Helsinki the 13th of June and ended in Åbo/Turku at the 20th, where Aranda was having a service at the shipyard.

The winds were weak and mainly from south until the last days of the expedition, when a low pressure system passed and the wind speed increased to 10-15 m/s, predominantly westerly.

During the expedition some extra zooplankton samples were taken at the stations BY15, BY5, BY2, Anholt E and Släggö on behalf of Umeå University. During the last day of the cruise the wave buoy at Huvudskär was visited and a smaller service was performed, figure 1.

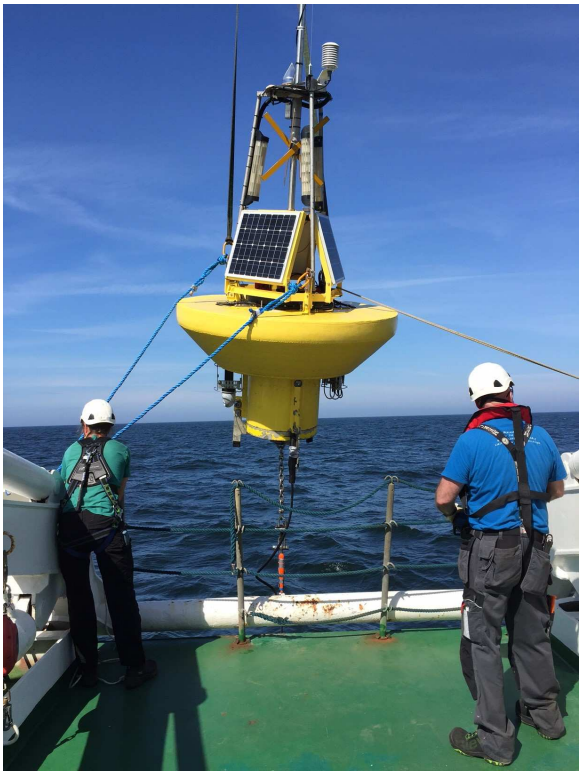


Figure 1. Service of the wave buoy at Huvudskär.

Unfortunately the concentrations of ammonia, NH4, could not be analyzed before Lysekil during his cruise due to instrumental problems. In the Lysekil a new instrument was delivered and ammonia could be analyzed at Å17 and onwards, se separate station list. Figures showing dissolved inorganic nitrogen, DIN, only contain nitrate+nitrite for all stations before Å17. In case of anoxic conditions, hydrogen sulfide present, DIN has been removed from the figures since DIN is almost only ammonia in anoxic waters.

During the sampling of LL19 there was a short circuit in the cable and the connection to the CTD/bottle carousel was lost. The cable could be reterminated and was ready to use again just before BY10, hence the stations LL17, BY20 and BY15 are missing data from the CTD.

On this cruise phytoplankton was analyzed on board by Malin Mohlin, the results are published in the Algaware report for June; http://www.smhi.se/oceanografi/oce_info_data/reports/alg/algsit16_6.pdf, below follows a summary.

The species diversity was large in the Skagerrak among the dinoflagellates, but it was the diatom *Proboscia alata* that dominated the phytoplankton community.

Diatoms were very common in the Kattegat, and similar to the Skagerrak it was *Proboscia alata* that was most abundant with an exception at Anholt E, where also *Dactyliosolen fragilissimus* and *Guinardia flaccida* were very common.

There were no visible surface accumulations of cyanobacteria during this cruise. However, filamentous cyanobacteria were visible by eye in the water at all stations in the Baltic Proper. When analyzing the samples from the surface, and down to 10 meters depth, it was mainly large amounts *Aphanizomenon flos-aquae*. The toxic species *Nodularia spumigena* was present in all samples but not dominating in abundance. Surface accumulations could arise if the weather keeps being stable with low winds and high water temperature.

SMHI analyzes satellite images to detect surface accumulations of cyanobacteria every day during the summer, available at http://www.smhi.se/vadret/hav-och-kust/algsituationen.

The Skagerrak

The temperature in the surface water was normal or just above normal for the season; it varied from 15 °C offshore to 17 °C closer to the coast. The surface salinity in outermost parts was normal and somewhat lower than normal closest to the coast, varying from 20-30 psu. The stratification both in temperature and salinity coincided at around 10 meters

All nutrient concentrations were very low in the surface layer in the entire area, which is normal for the summer season. Phosphate concentrations varied between 0.02-0.05 µmol/l, nitrate and nitrite concentrations was below the limit of quantification, LOQ, (<0,10 µmol/l and <0.02 µmol/l respectively). Concentrations of silicate were around 0.1 µmol/l except at P2, where levels of 0.7 µmol/l were measured. At all stations a peak in fluorescence was observed at 20-30 meters, at Å13 there was a major peak at 25 meter. At 10-20 meters the water was oversaturated with oxygen which indicates higher biological activity, nutrient concentrations increased first at a depth of 30 meters and below. The bottom water was well oxygenated, even at Släggö in the mouth of Gullmarsfjorden.

The Kattegat and the Sound

The temperature in the surface water was normal for the season and varied between 16 and 17.5 °C. The salinity in the surface layer was also normal for the season except for in the Sound where it was higher than normal at around 10-15 meters. Lowest measured value in the surface was 9 psu and the highest, at 28 psu, came from 10 meters at Fladen. The temperature and salinity stratification in the area could be found between 5 to 15 meters.

All nutrient levels in the upper layer were very low which is normal for the summer. Phosphate concentrations varied between 0.04-0.30 µmol/l, nitrate and nitrite var below of around the limit of quantification, LOQ, (<0,10 µmol/l and <0.02 µmol/l respectively) and silicate varied between 0.4 and 0.9 µmol/l. Highest nutrient concentrations was found in the Sound. Nutrient levels above LOQ were present at 15-20 meters and below. Oxygen conditions in the bottom water were good and the lowest concentration measured was 4.5 ml/l in the Sound. A fluorescence peak at 10-25 meter could be seen at all stations, highest in the Sound at W Landskrona between 10 and 15 meters.

Egentliga Östersjön

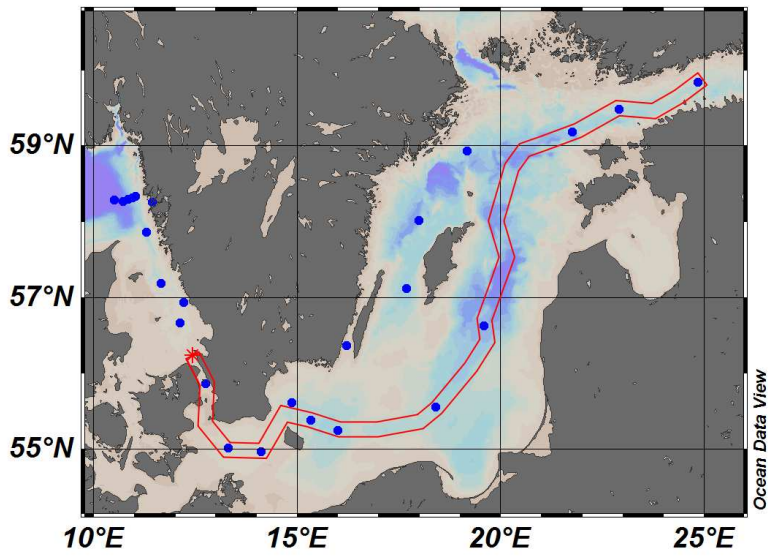
The temperature in the surface water was normal and measured between 14-15 °C, warmest in the south western parts of the Baltic Proper. Surface salinity was normal or just above and varied between 7 and 8 psu.

The halocline in the Baltic Proper varied between 50 and 80 meters, except for in the Arkona basin where it was found a bit shallower, at around 35-40 meters. A well-developed summer thermocline could be found at 15-20 meters.

Concentrations of nitrite in the surface were around 0.03-0.04 µmol/l and nitrate levels were below the limit of quantification at 0.10 µmol/l, except for BY5 where nitrate concentration was just over 0.35 µmol/l. Not until depths of 50 meters or below the concentrations of nitrate and nitrite started to increase. Phosphate concentrations in the surface were in the Western Gotland Basin slightly under normal and in the Arkona Basin somewhat higher than normal, in the remaining parts of the Baltic Proper they were at normal levels for the season. The concentrations in the central parts of the Baltic Proper were around 0.10 µmol/l and in the Arkona and Bornholm Basin around 0.30 µmol/l. Concentrations of silicate were higher than normal and varied between 9-14 µmol/l.

In the Western Gotland Basin there was a quick transition from the oxic and the anoxic layer at 80 meters, at BY38 acute hypoxia (dissolved O_2 <2ml/l) was found at around 70 meters and hydrogen sulphide from 80 meters and below. In the northern part of the Eastern Gotland Basin, BY20, oxygen concentrations varied with just above 2.0 ml/l at 80 meters, but hydrogen sulphide did not appear until close to the bottom at 175-195 meters. At BY15 Gotland Deep the whole water column was still oxygenated, however the concentrations were low and acute hypoxia was found already at 70 meters. Acute hypoxia was also observed in the Hanö Bay from about 60 meters and in the Bornholm Basin from 70 meters, which is a deterioration from the last measurements in May.

Measurements of fluorescence and samples of phytoplankton showed biological activity in the surface layer in the entire Baltic Proper, and some fluorescence peaks were observed around 10 meters. No obvious surface accumulations were observed but there were plenty of cyanobacteria present in the upper layer that could surface and accumulate if calm and warm weather continues.



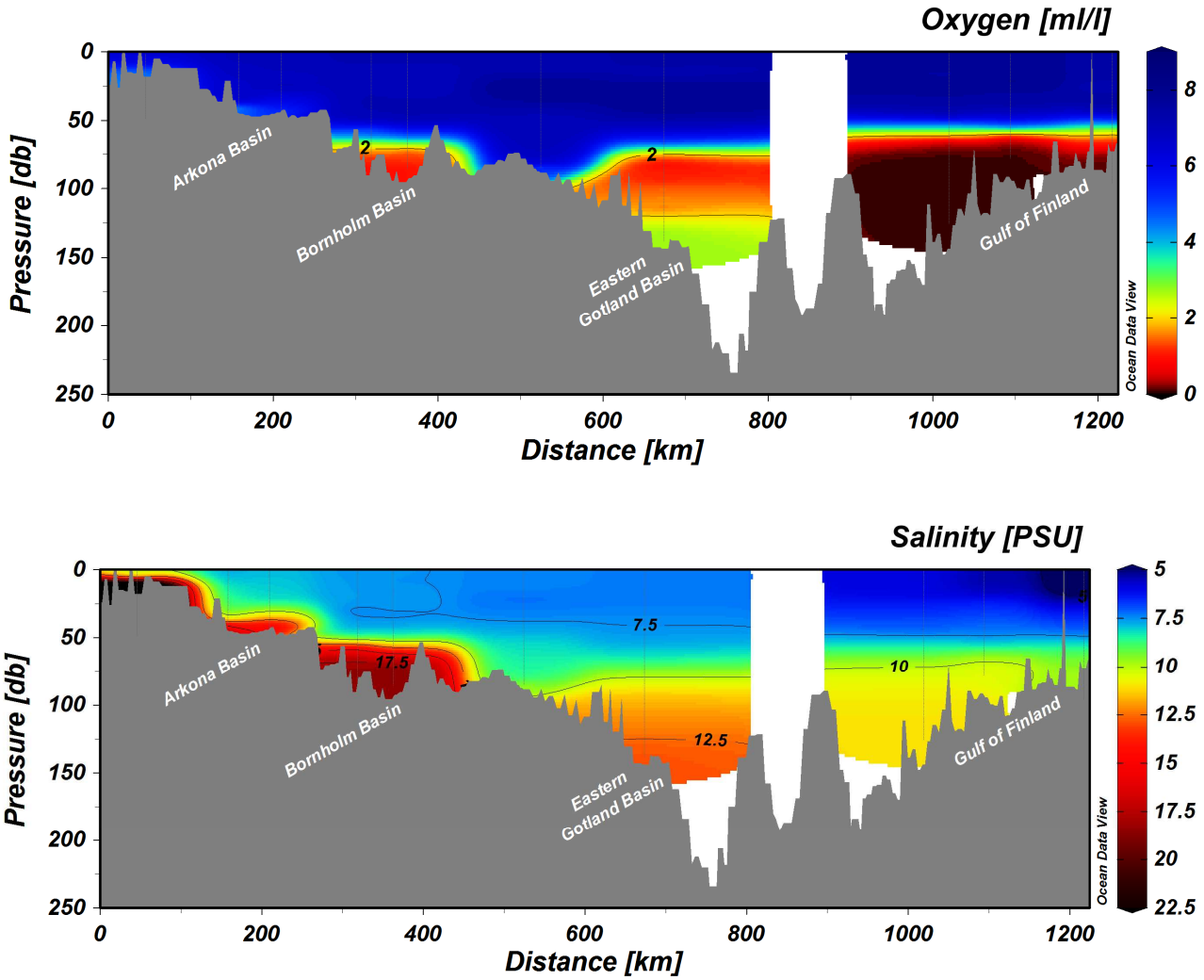


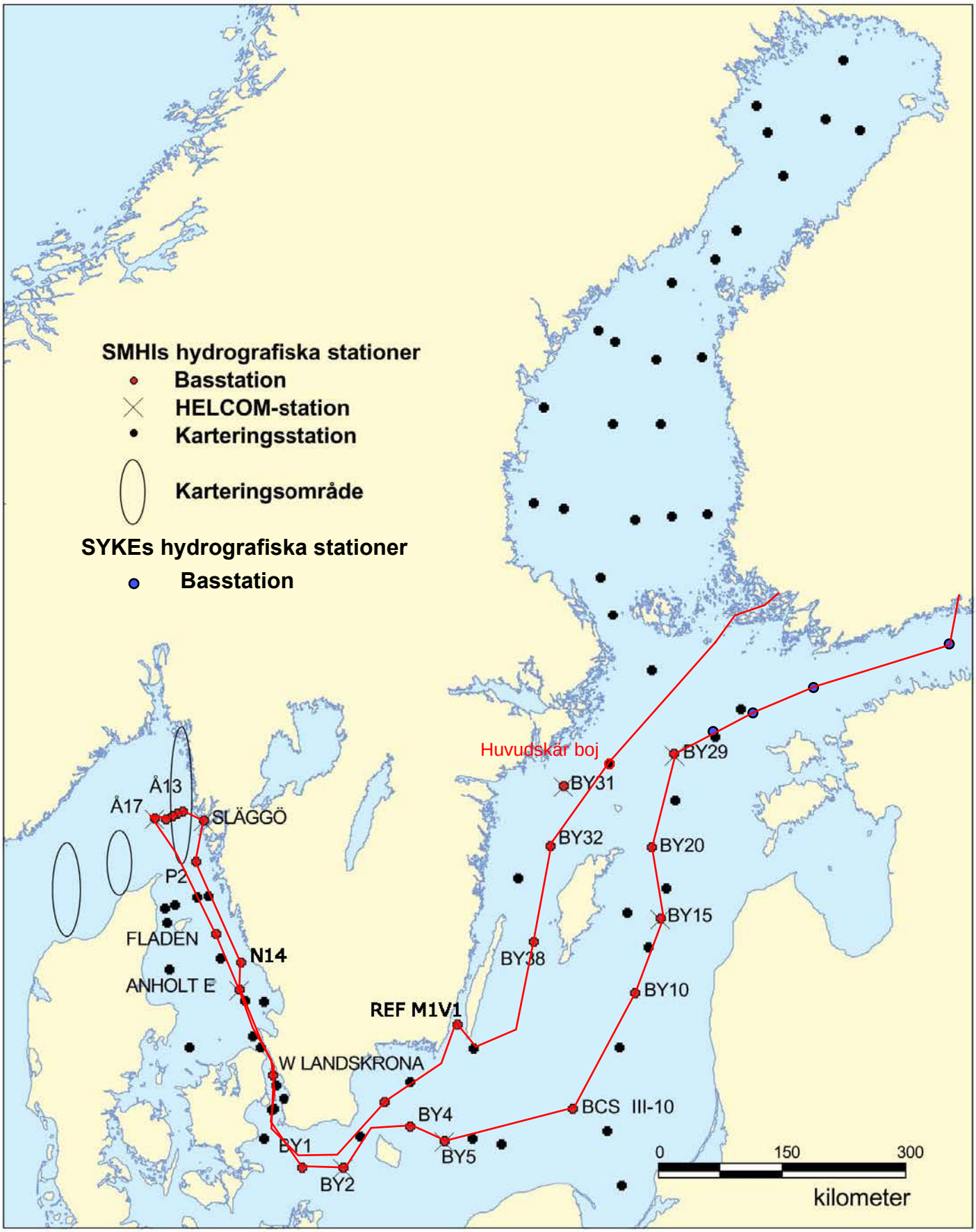
Figure 2. Transect showing oxygen and salinity through the Baltic Proper, from the Sound to the Gulf of Finland.

PARTICIPANTS

Name		Institute
Örjan Bäck	Chief scientist	SMHI
Sara Johansson		SMHI
Daniel Bergman Sjöstrand		SMHI
Sari Sipilä		SMHI
Johanna Linders		SMHI
Malin Mohlin		SMHI

APPENDICES

- Track chart
- Table over stations, analyzed parameters and number of sampling depths
- Map showing bottom oxygen concentrations
- Vertical profiles for normal monitoring stations
- Monthly average surface water plots for normal monitoring stations


SMHIs hydrografiska stationer
Basstation
HELCOM-station
Karteringsstation
Karteringsområde
SYKEs hydrografiska stationer
Basstation
Huvudskär boj
BY29
BY31
BY32
BY20
BY15
BY38
BY10
REF M1V1
BCS III-10
BY4
BY5
BY1
BY2
W LANDSKRONA
N14
ANHOLT E
FLADEN
P2
SLÄGGÖ
Å17
Å13
0
150
300
kilometer

Date: 2016-06-22

Ship: AR
Year: 2016

Ser no	Stat code	Proj	Stat name	Lat	Lon	Start date yyyymmdd	Start time hhmm	Bottom depth m	Secchi depth m	Wind di ve	Air temp C	Air pres hPa	WCWI elac aove tueo hdsb	No de	Temp_bottle	Temp_cast	Salt_bottle	Salt_cast	Phosphate	Doxy_bottle	Doxy_cast	H2S	Phosphorus	Nitrite	Nitrate	Nitrogen	Ammonia	Total_N	Silicate-Si	Chlorophyll	Depth_zone	Phytoplankton	Cyanobacteria	Light_level	Yellow_lake	Auxo_a	Cod_a	Cod_n	Cod_m
0326	GFXX29	SYKE	BY23/LL 7	5950.791	02450.2722016-06-13	11:50	102	4	24	9	12	1006	1430	13	x	x	-	x	-	x	-	x	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-
0327	BPNX60	SYKE	LL12	5929.011	02253.8122016-06-13	19:00	83	4	25	7	12	1007	1120	11	x	x	-	x	-	-	-	x	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-
0328	BPNX62	SYKE	LL15	5911	02144.8122016-06-13	21:55	129		24	5.0	12	1008	1220	14	x	x	-	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0329	BPNX35	SYKE	LL19	5852.91	02019.67 2016-06-14	02:25	176		22	2.4	12	1008	1130	16	x	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
0330	BPEX26	BAS	BY20 FÅRÖDJUPET	5759.89	01952.73 2016-06-14	08:15	203	6	14	6	13	1008	1120	17	x	-	-	-	-	x	-	x	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	x
0331	BPEX21	BAS	BY15 GOTLANDSDJ	5718.3	02004.57 2016-06-14	16:40	249	6	07	8	14	1006	1230	21	x	-	-	-	-	x	-	-	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	x
0332	BPEX13	BAS	BY10	5638.021	01935.0892016-06-14	20:10	145		08	8.5	15	1004	1230	15	x	x	-	x	-	x	-	-	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-
0333	BPSE11	BAS	BCS III-10	5533.32	01824.01 2016-06-15	04:30	90		15	5	15	1001	1320	12	x	x	-	x	-	x	-	-	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-
0334	BPSB07	BAS	BY5 BORNHOLMSDJ	5515	01559.0472016-06-15	11:00	91	6	10	5.4	15	1000	1230	15	x	x	-	x	x	x	-	-	x	-	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-
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0345	SKEX14	BAS	Å13	5820.37	01101.6722016-06-17	02:50	96		26	6	16	1001	2730	10	x	x	-	x	-	x	-	-	x	-	x	x	x	x	-	-	x	-	-	-	-	-	-	-	-	-
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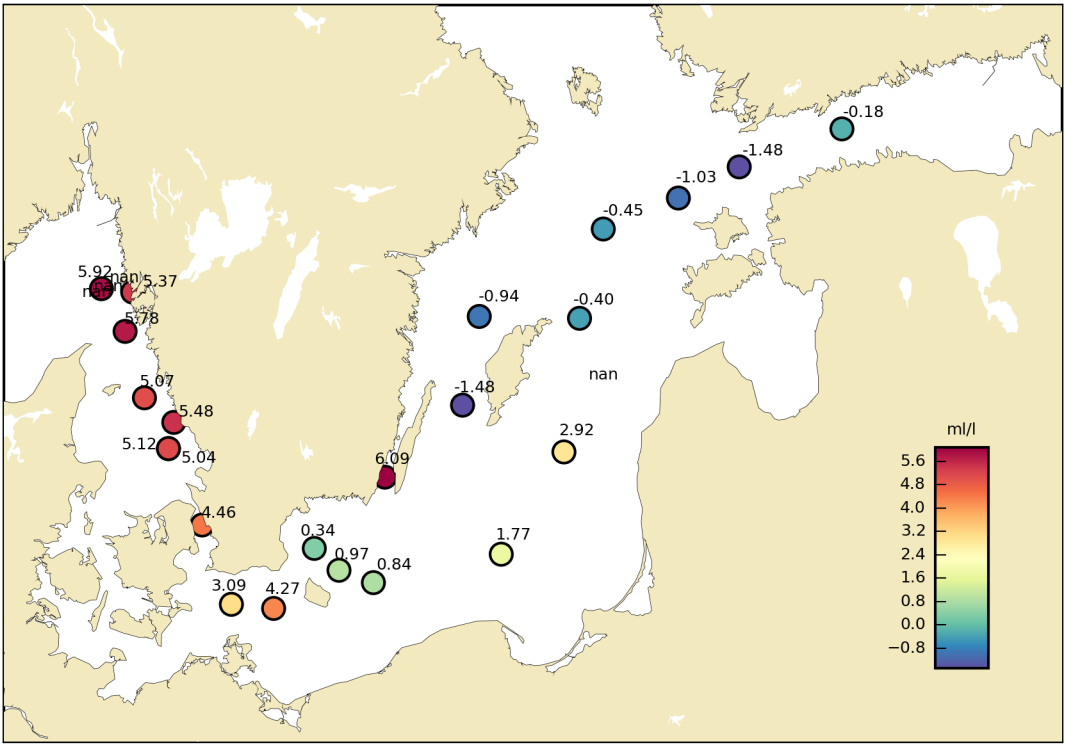
0352	BPWX45	BAS	BY38 KARLSÖDJ	5707.03	01740.12 2016-06-19	01:40	111		24	9	14	1011	1340	14	x	x	-	x	-	x	-	x	x	-	x	x	x	x	-	-	x	-	-	-	-	-	-	-	-	x
0353	BPWX38	BAS	BY32 NORRKÖPING	5801.012	01759.0722016-06-19	07:15	202	5	23	8.9	14	1012	2730	17	x	x	-	x	-	x	-	x	x	-	x	x	x	x	-	-	x	-	-	-	-	-	-	-	-	-
0354	BPNX00	EXT	HUVUDSKÄR	5855.928	01910.0782016-06-19	14:10	95	5	20	6	13	1014	1130	12	-	x	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bottom water oxygen concentration (ml/l)

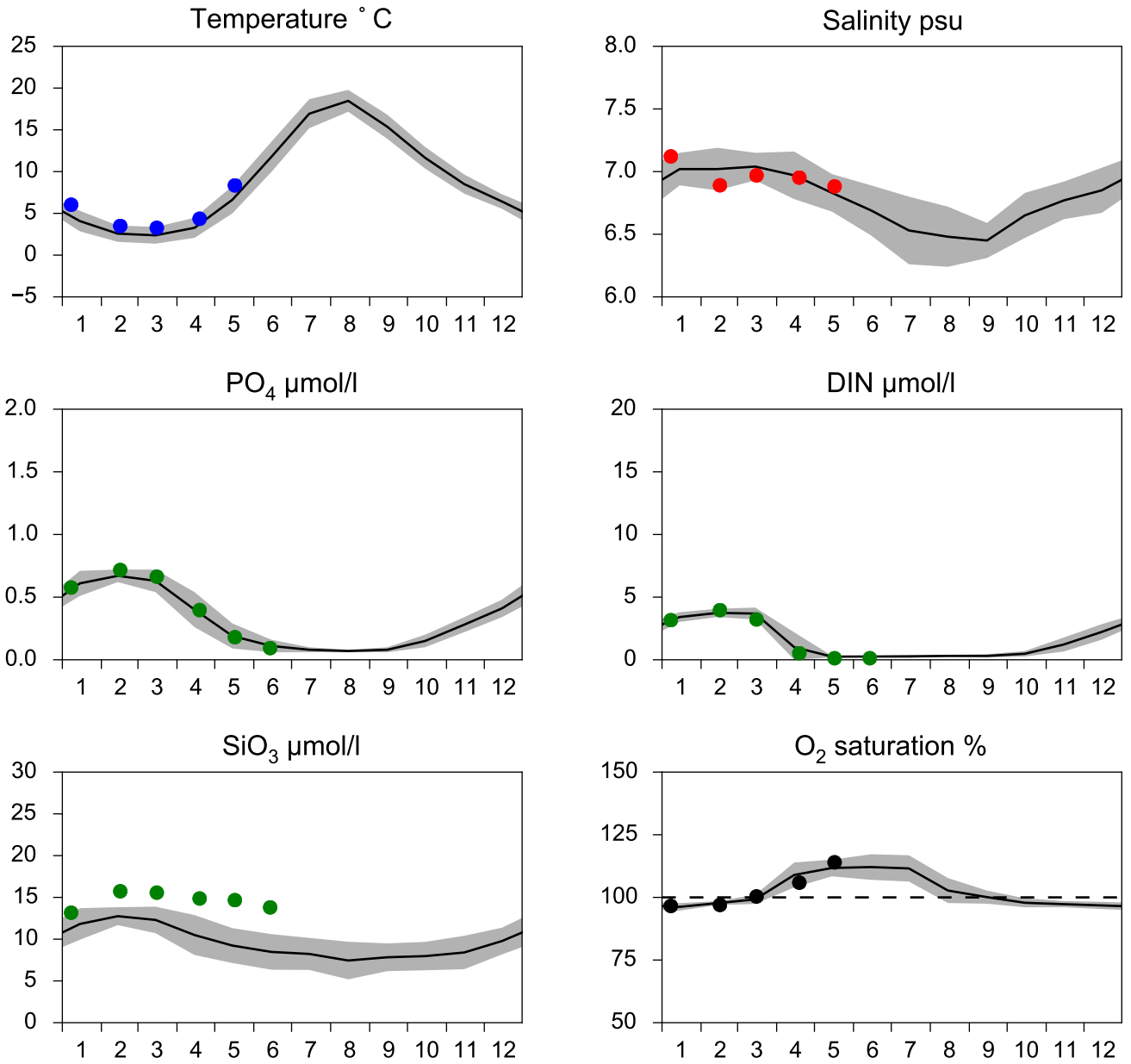
Country: Finland
Ship : Aranda
Date : 20160613-20160620
Series : 0326-0354



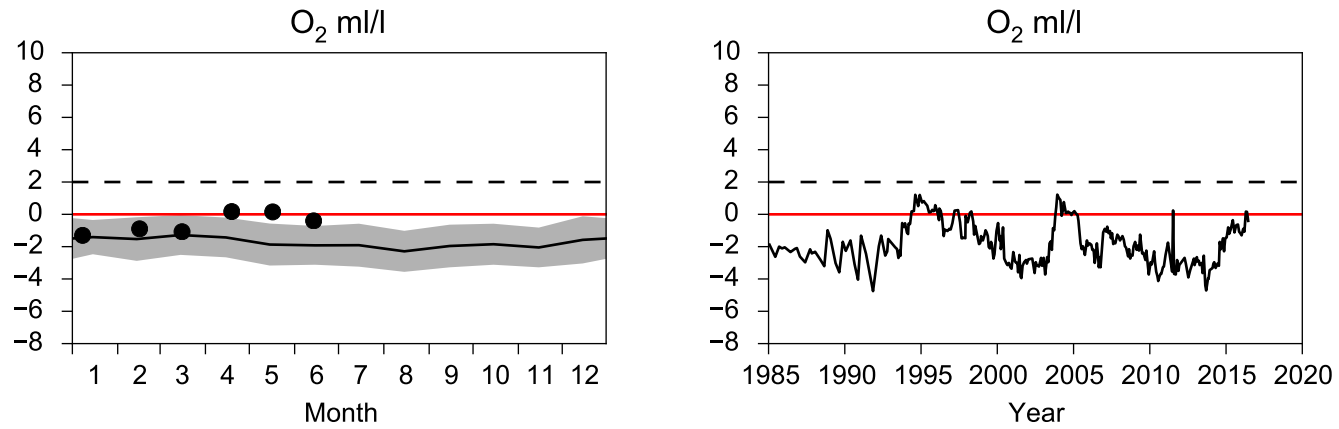
STATION BY20 FÅRÖDJ SURFACE WATER (0-10m)

Annual Cycles

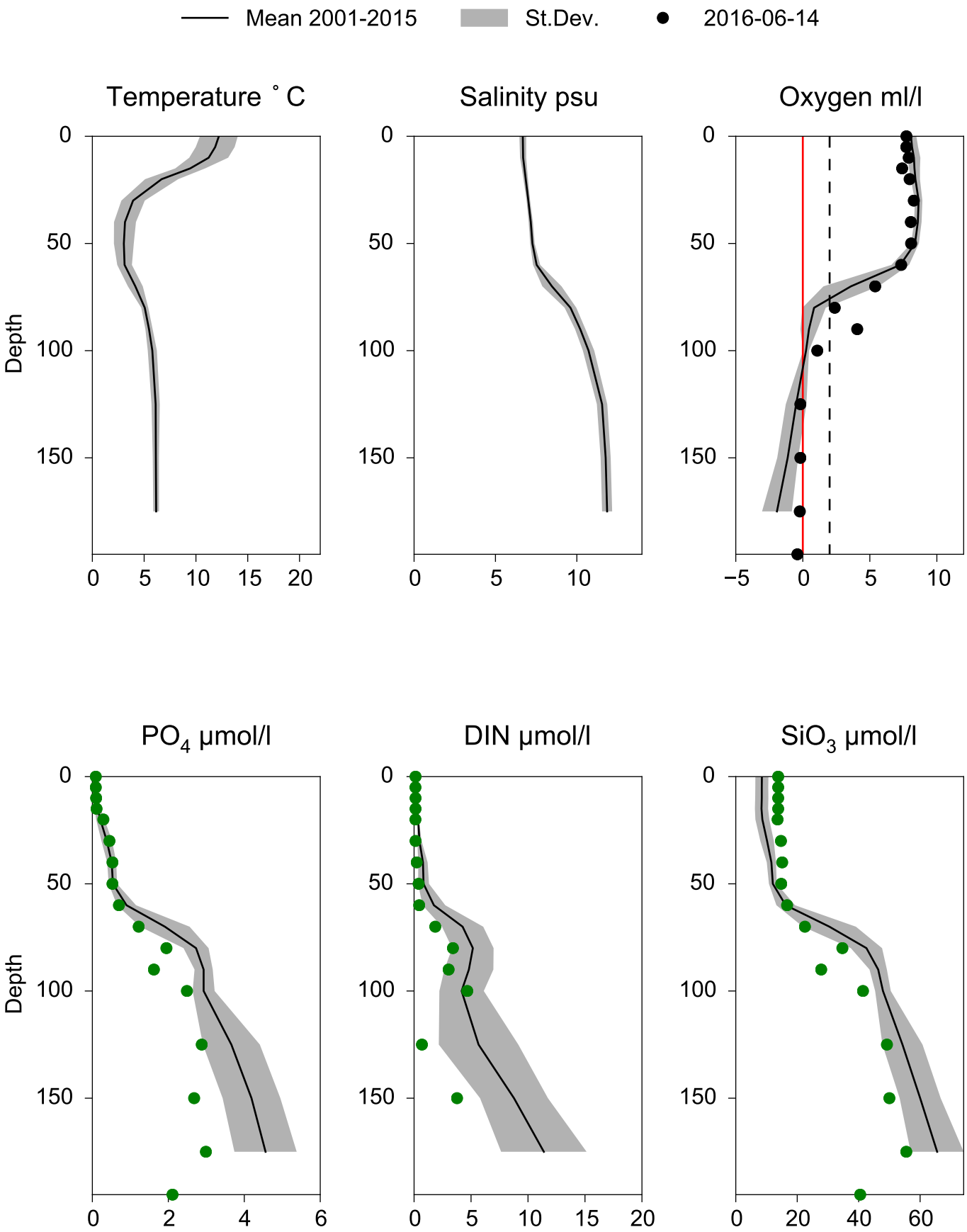
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 175 m)



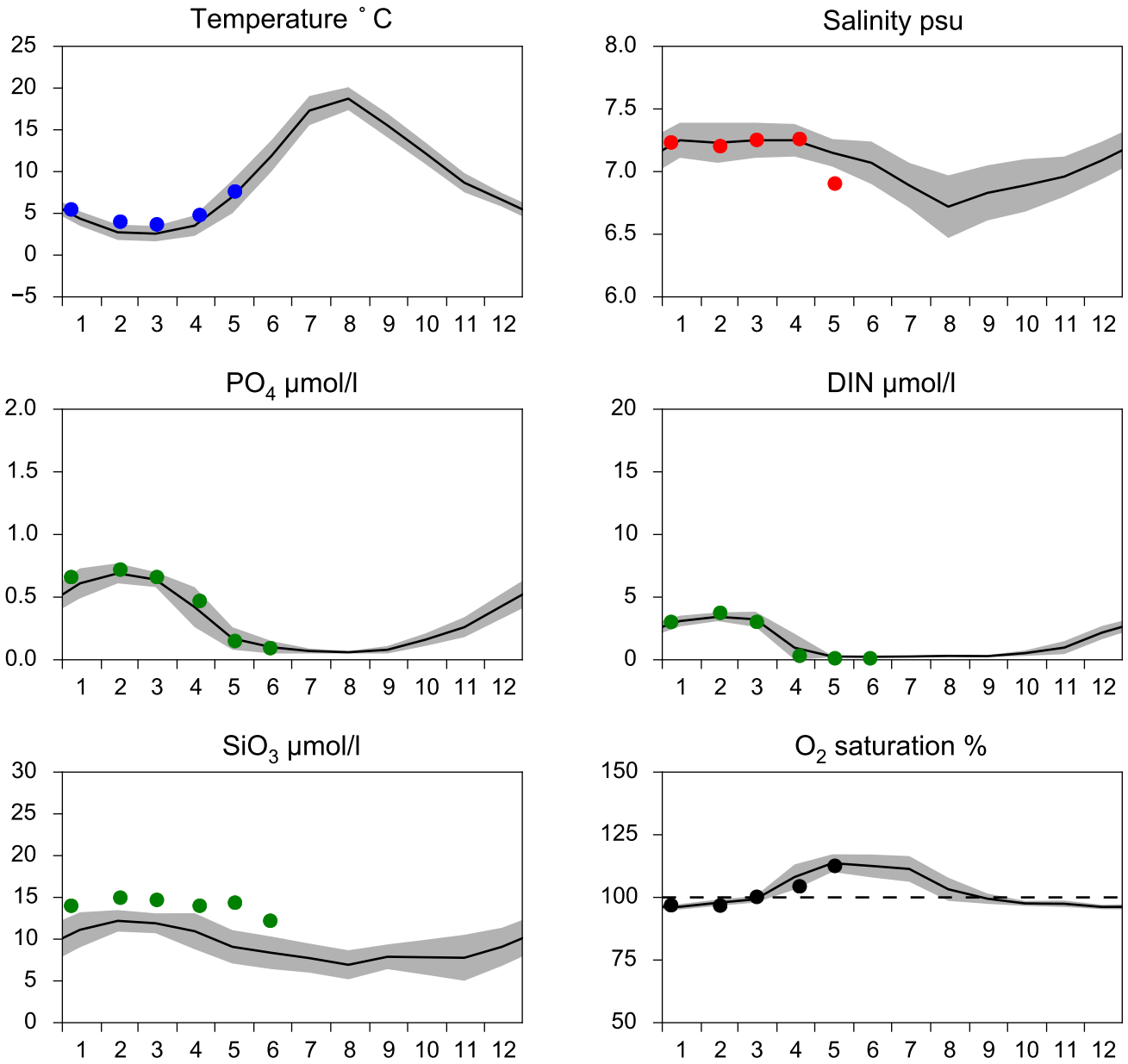
Vertical profiles BY20 FÅRÖDJ
June



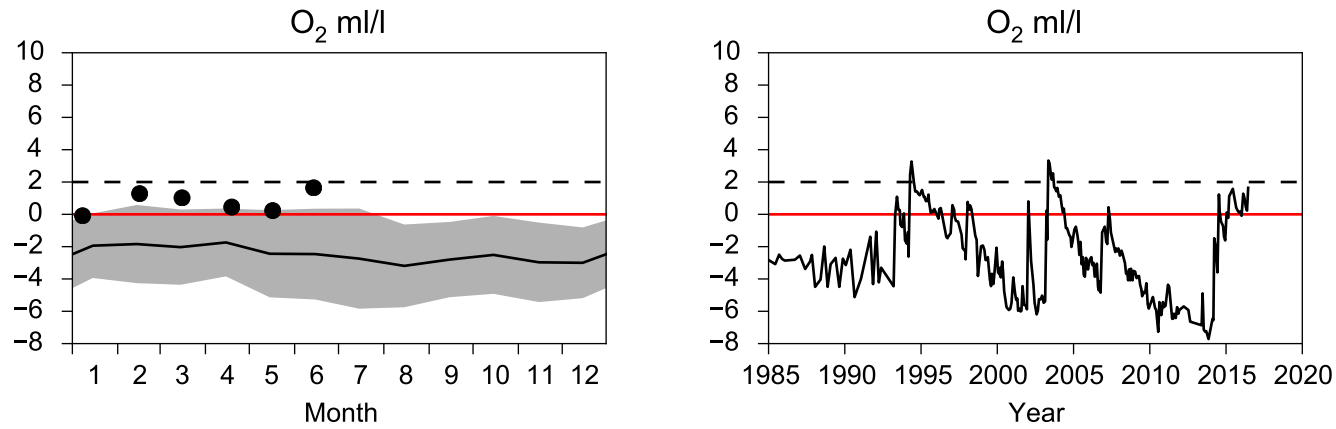
STATION BY15 GOTLANDSDJ SURFACE WATER (0-10m)

Annual Cycles

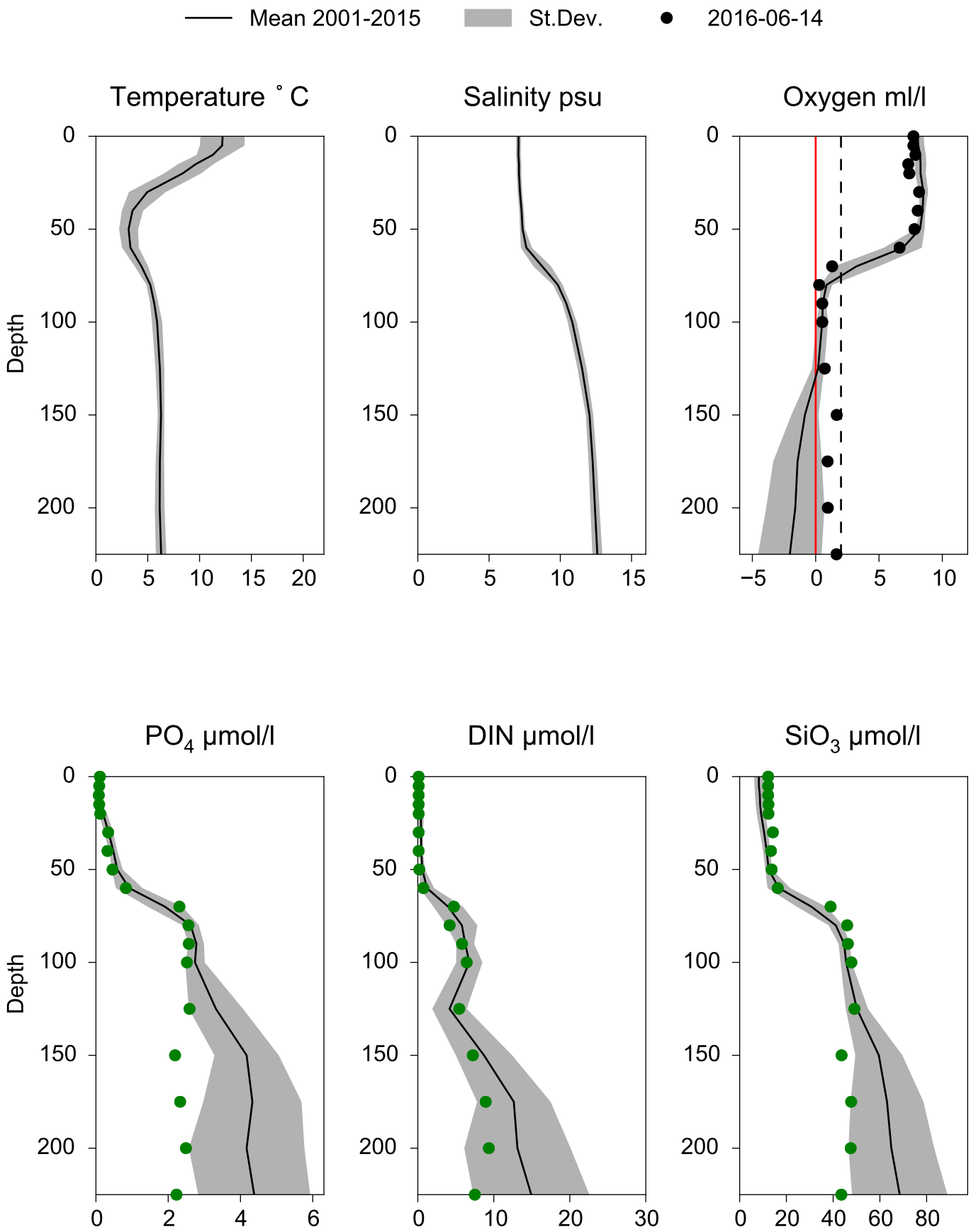
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 225 m)



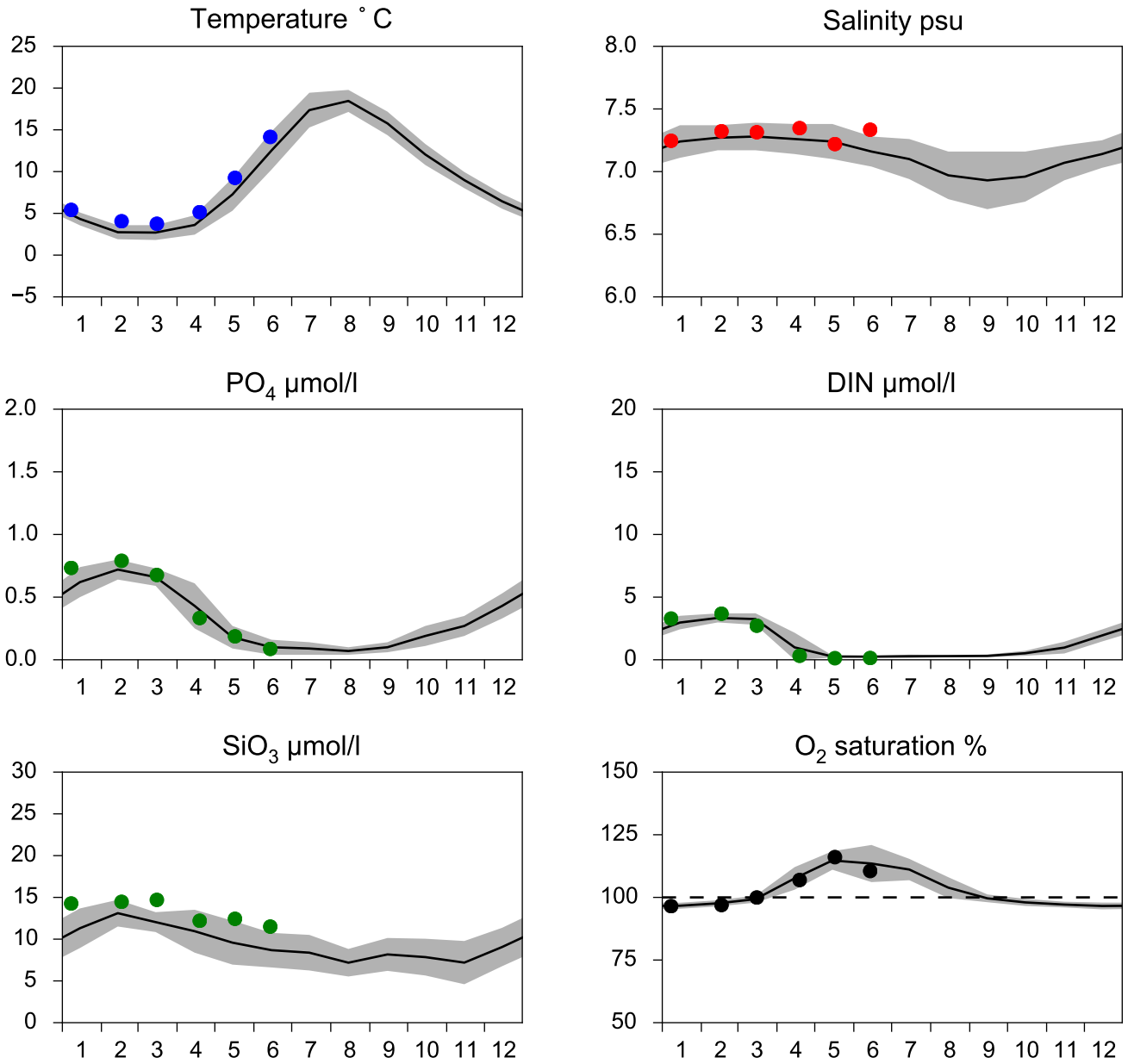
Vertical profiles BY15 GOTLANDSDJ
June



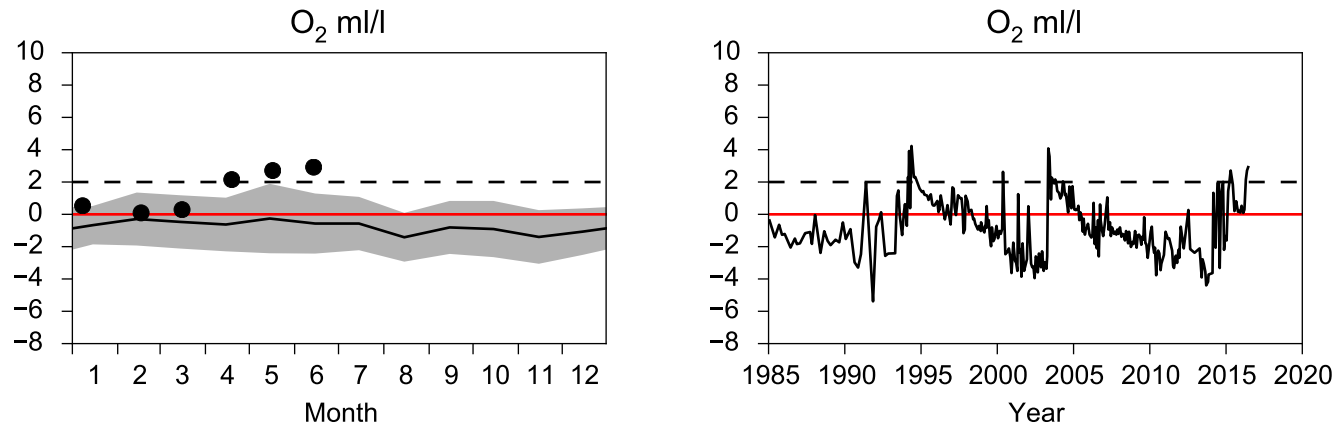
STATION BY10 SURFACE WATER (0-10m)

Annual Cycles

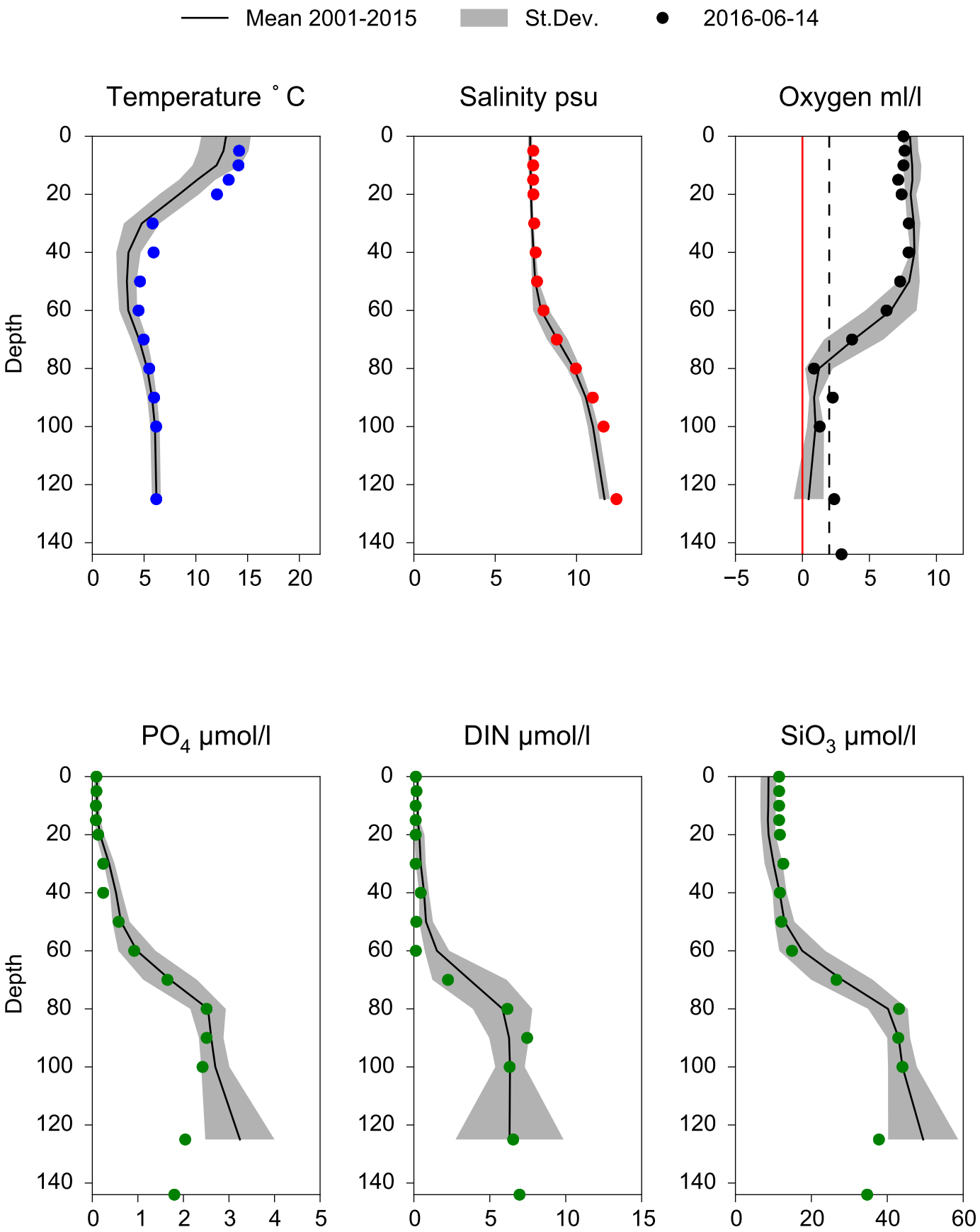
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 125 m)



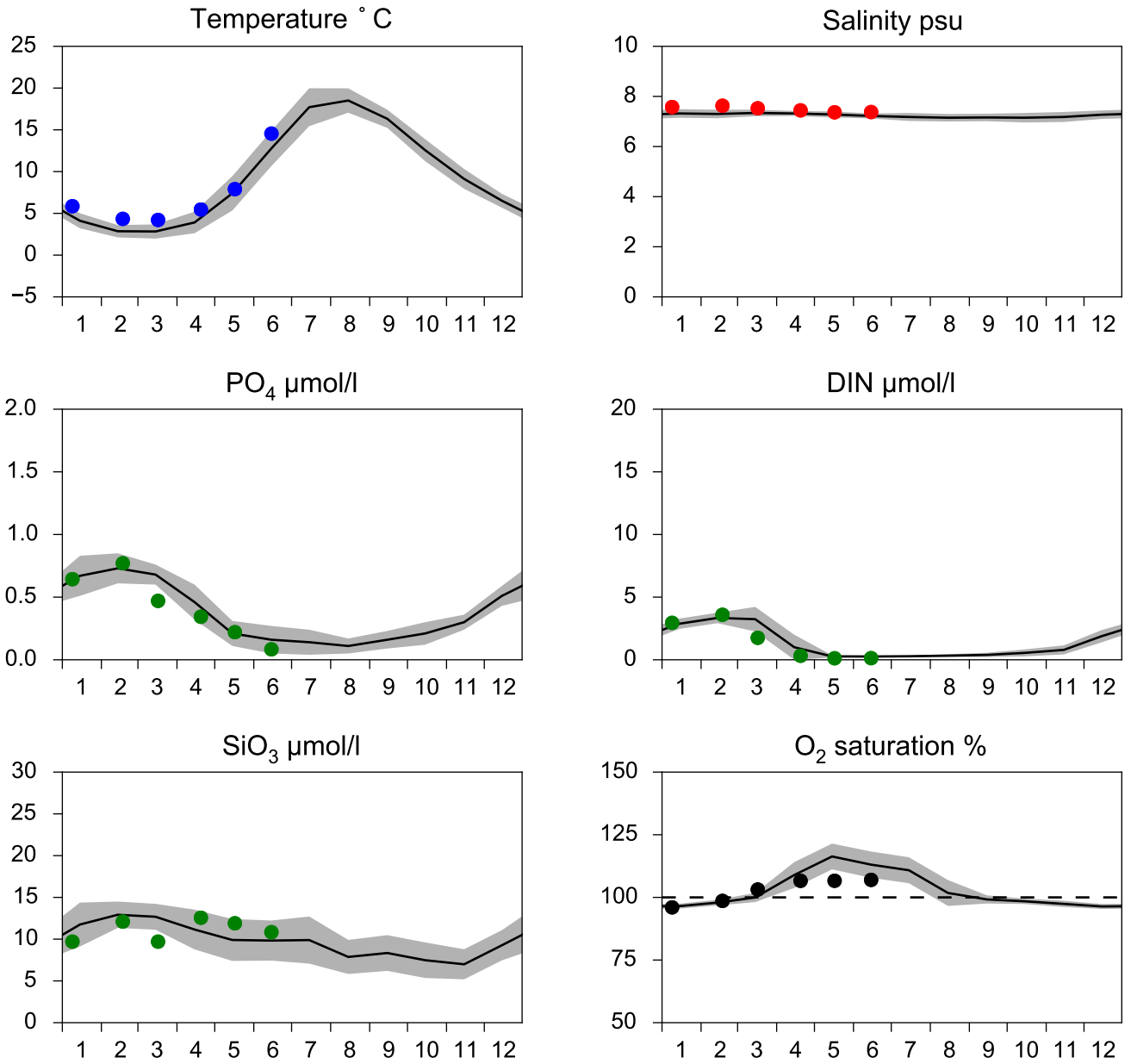
Vertical profiles BY10
June



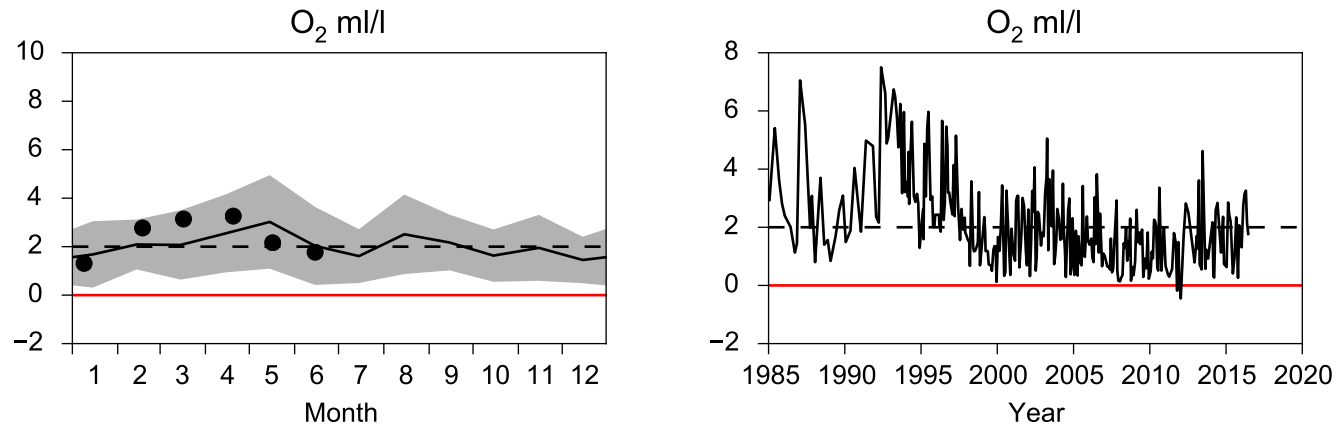
STATION BCS III-10 SURFACE WATER (0-10m)

Annual Cycles

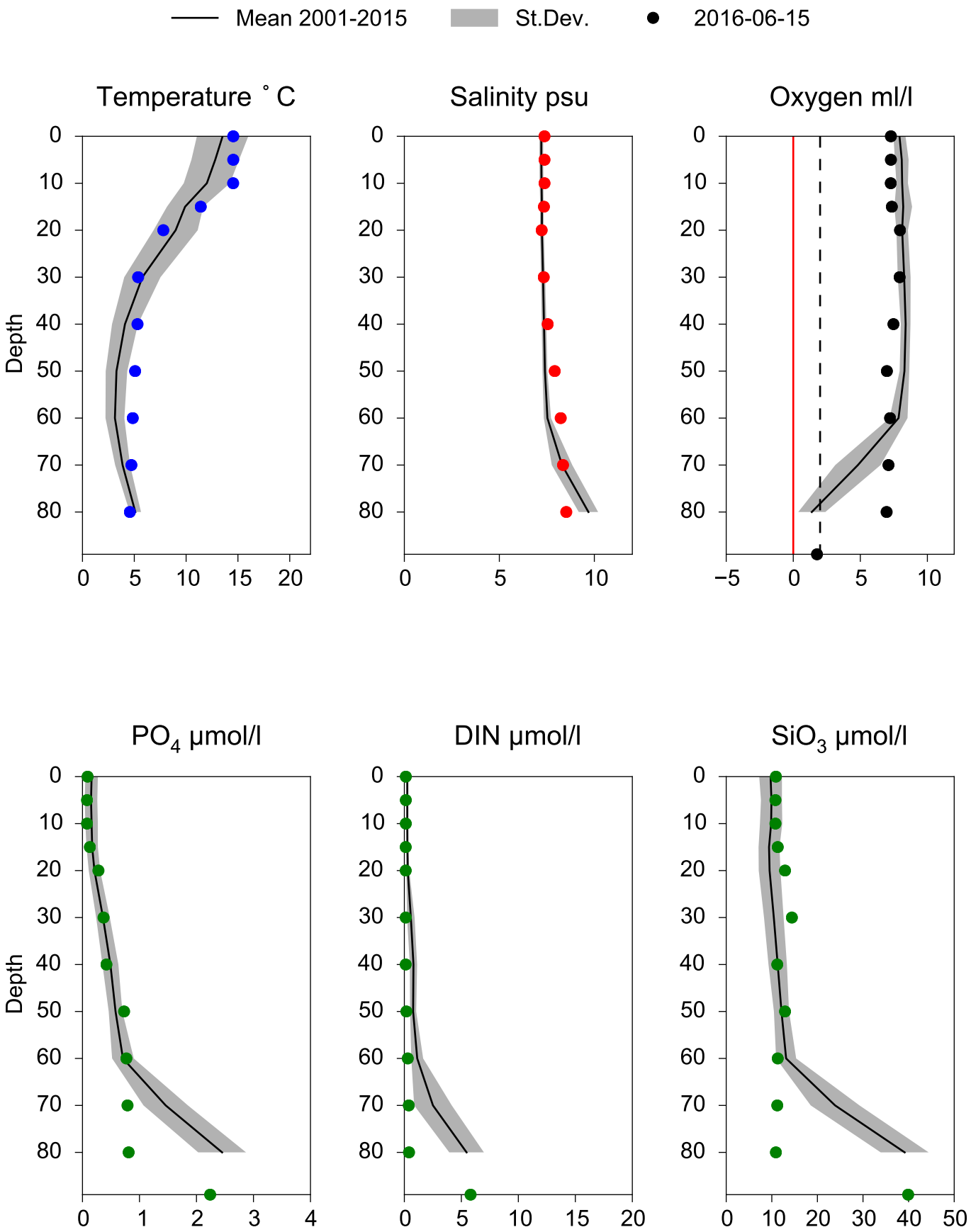
Mean 2001-2015 | St.Dev. | 2016



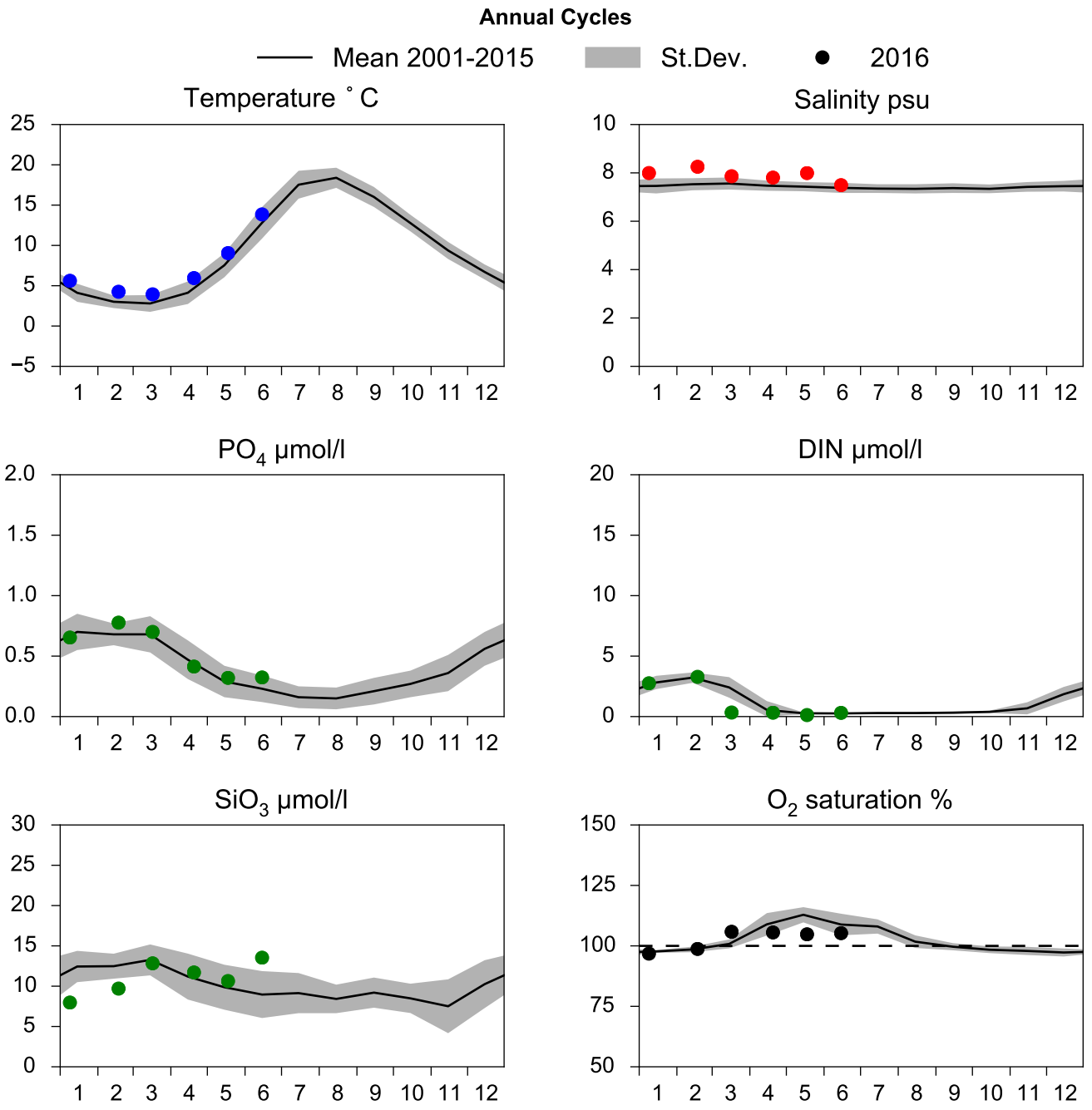
OXYGEN IN BOTTOM WATER (depth >= 80 m)



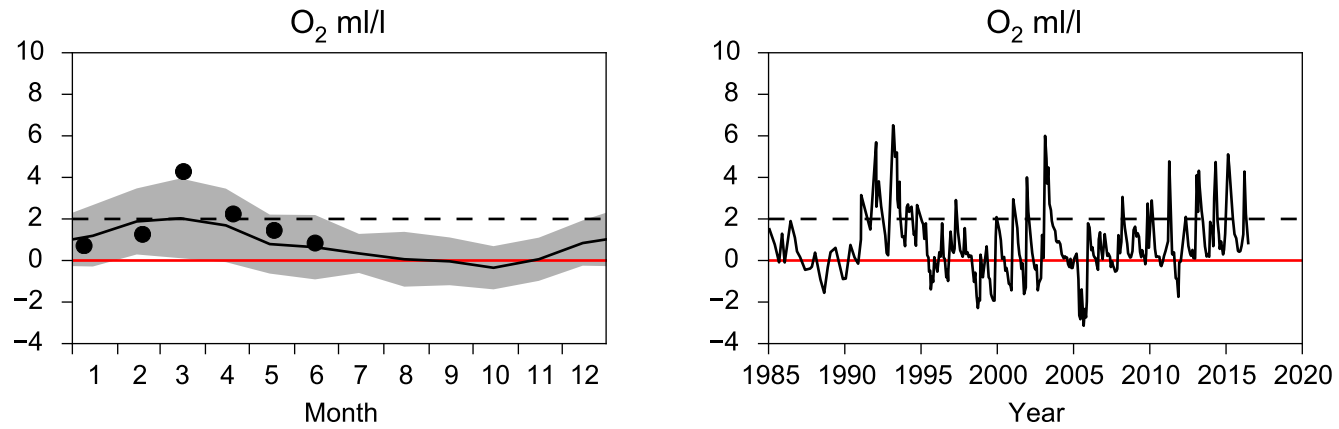
Vertical profiles BCS III-10
June



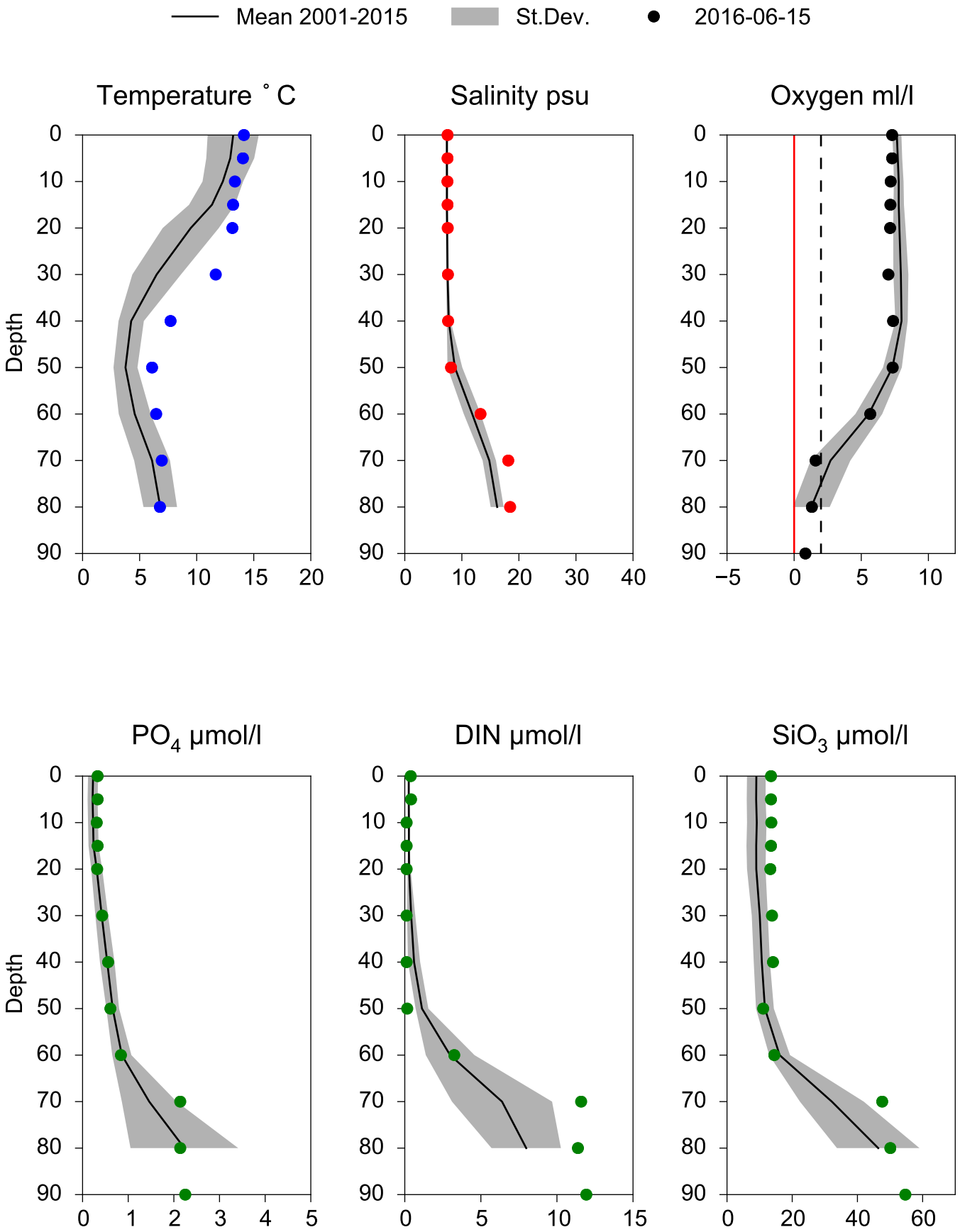
STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10m)



OXYGEN IN BOTTOM WATER (depth >= 80 m)

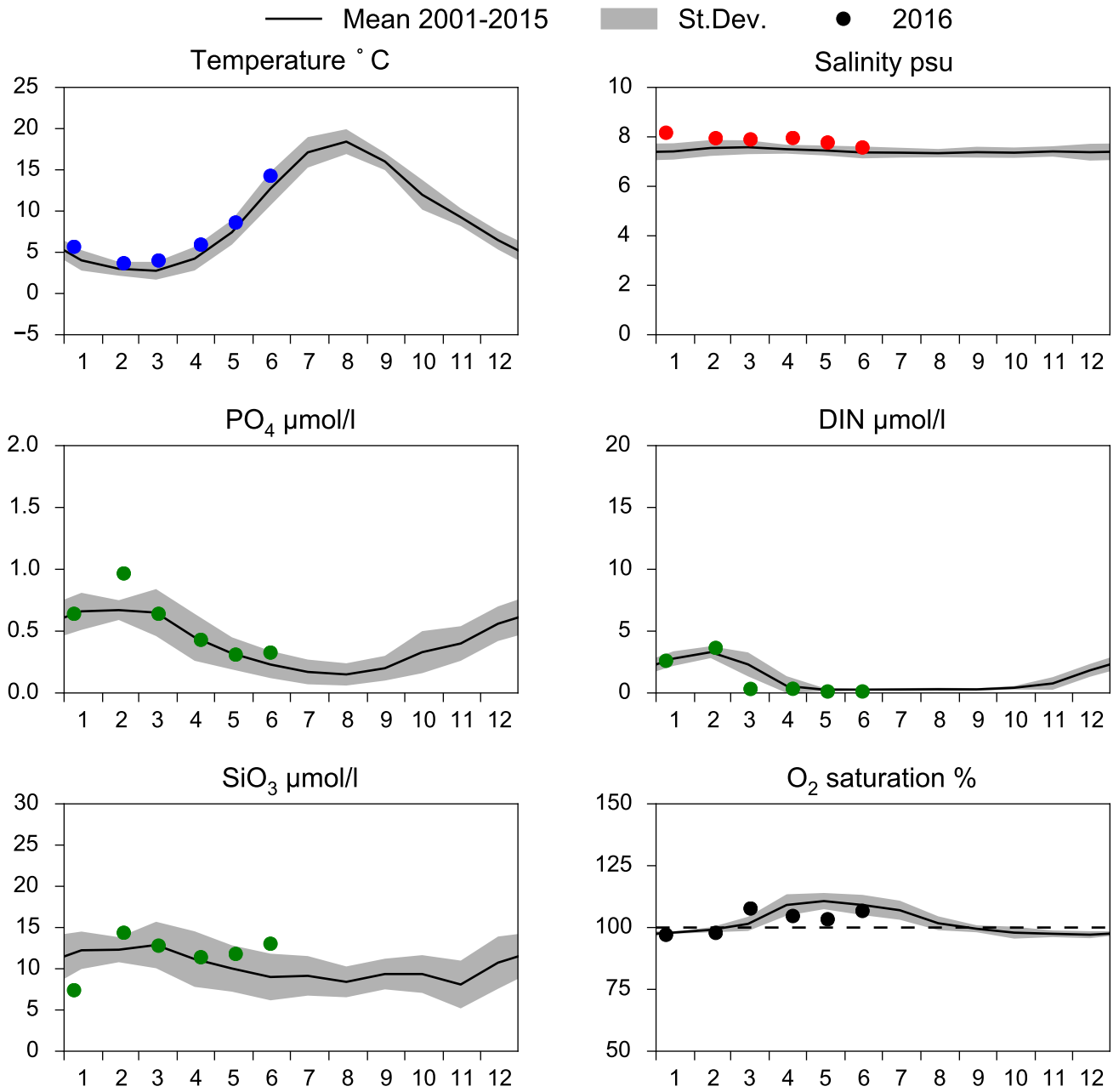


Vertical profiles BY5 BORNHOLMSDJ
June

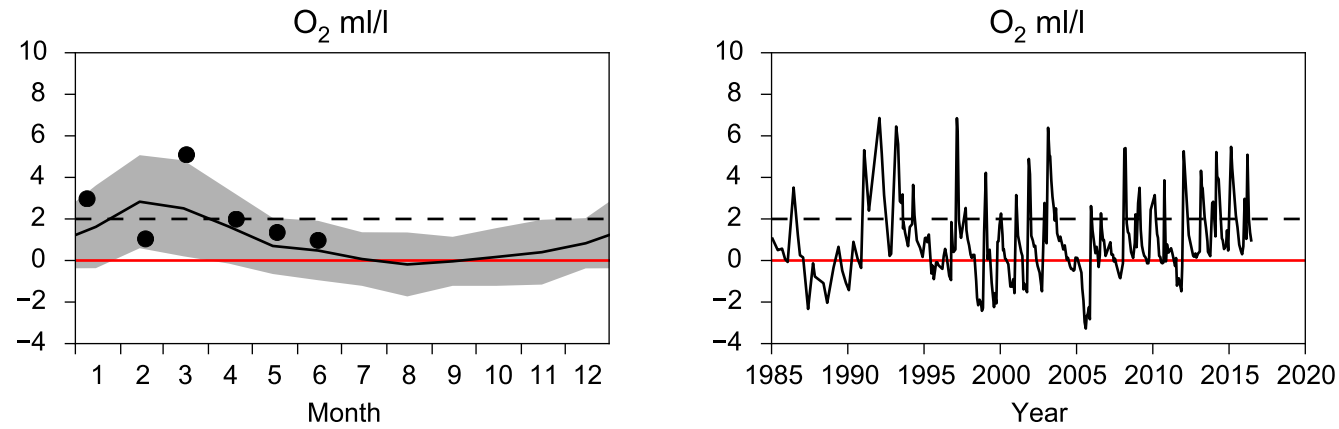


STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10m)

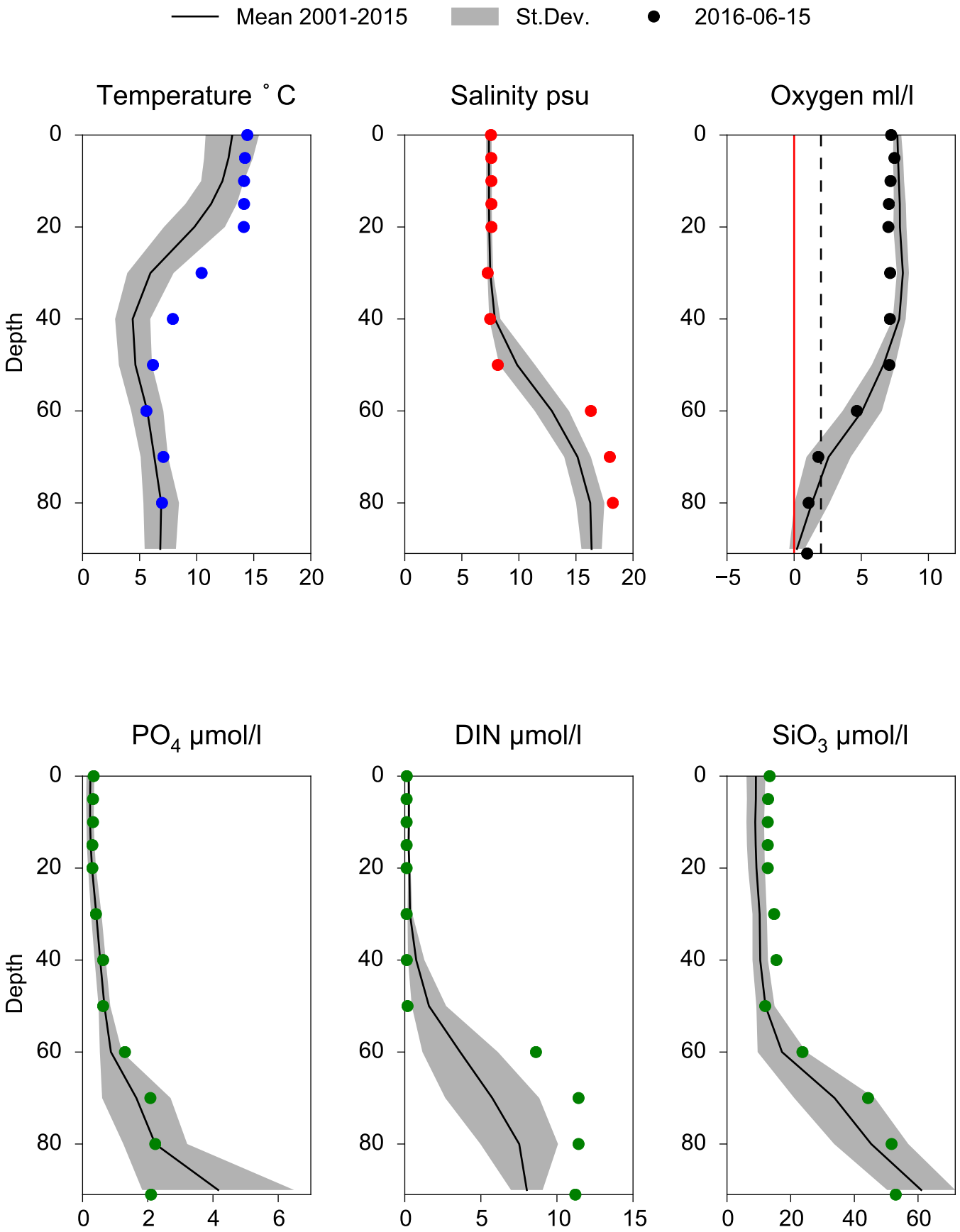
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)



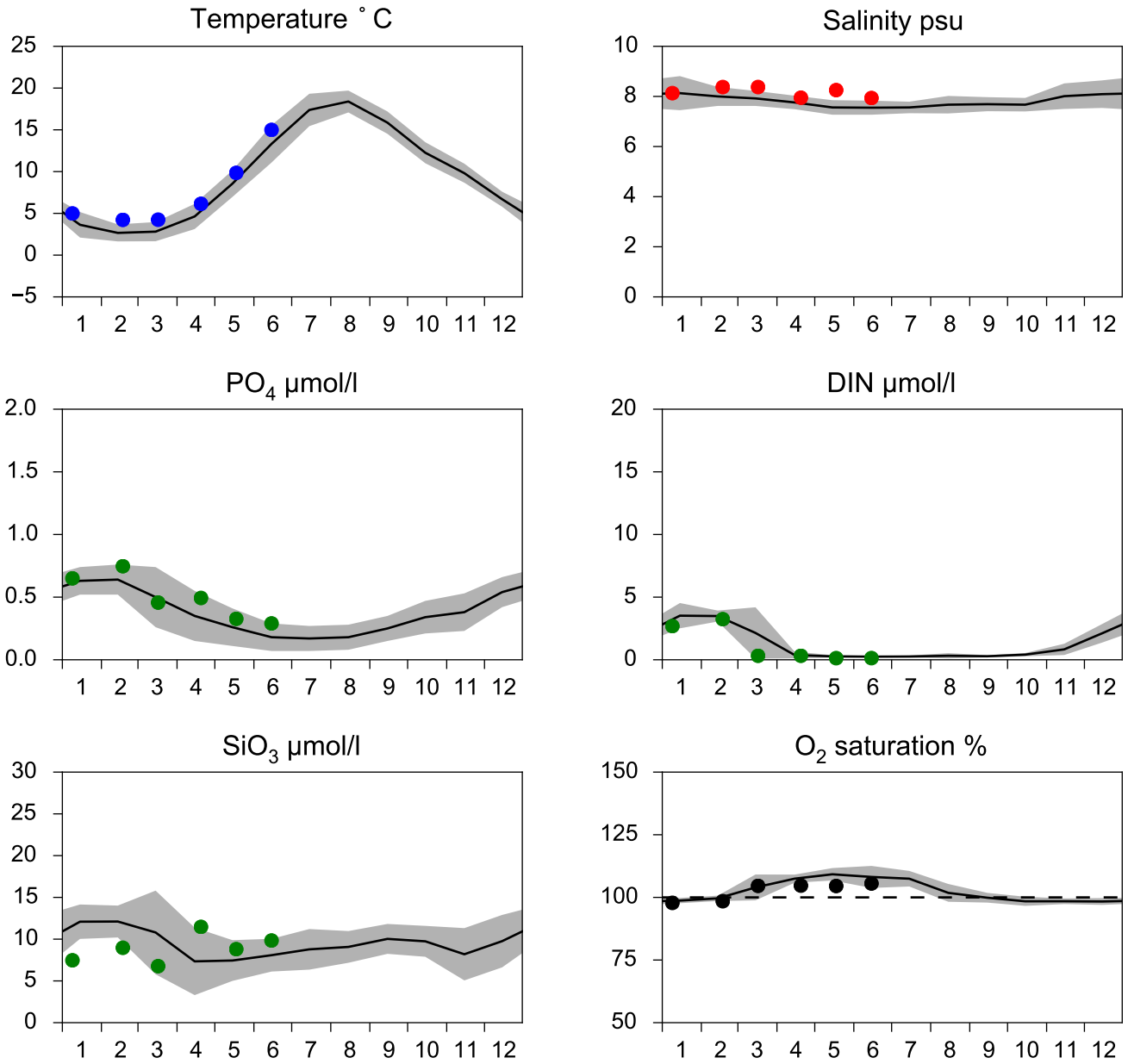
Vertical profiles BY4 CHRISTIANSÖ
June



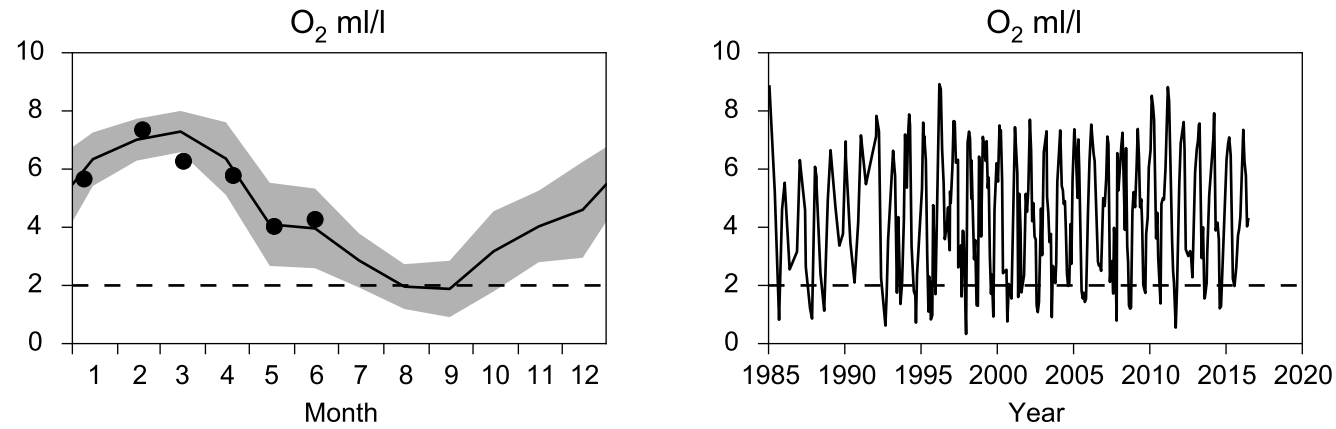
STATION BY2 ARKONA SURFACE WATER (0-10m)

Annual Cycles

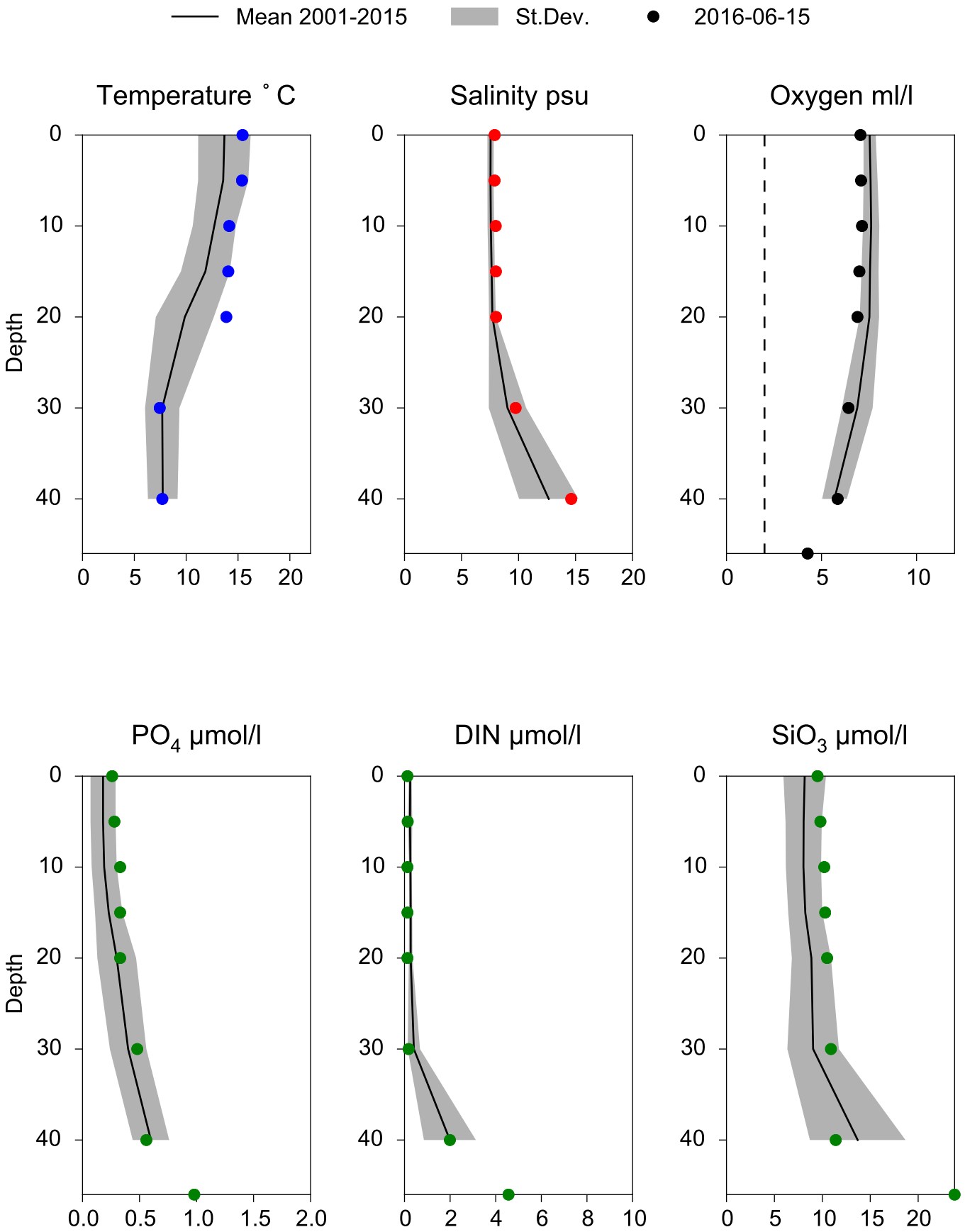
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 40 m)



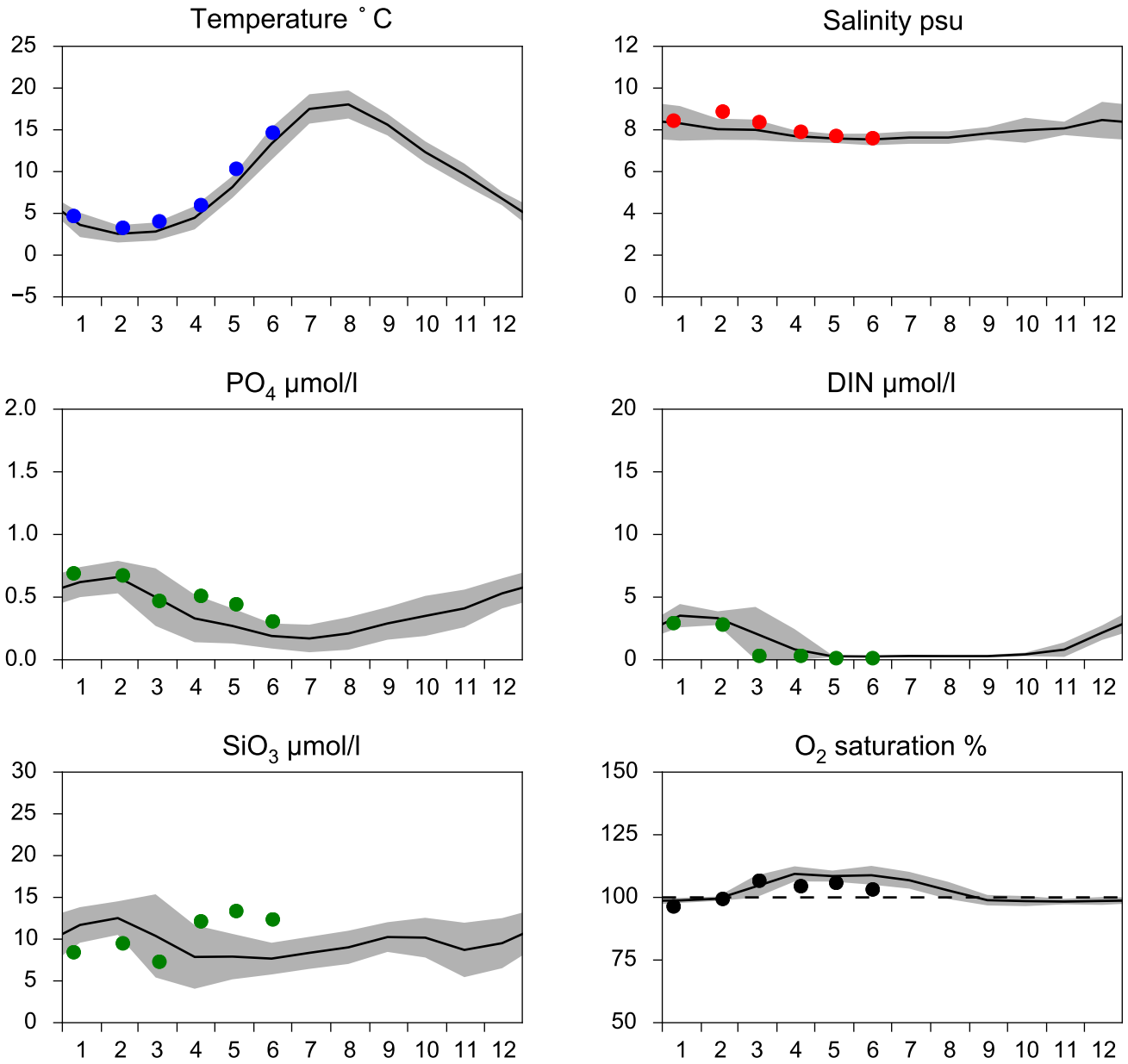
Vertical profiles BY2 ARKONA
June



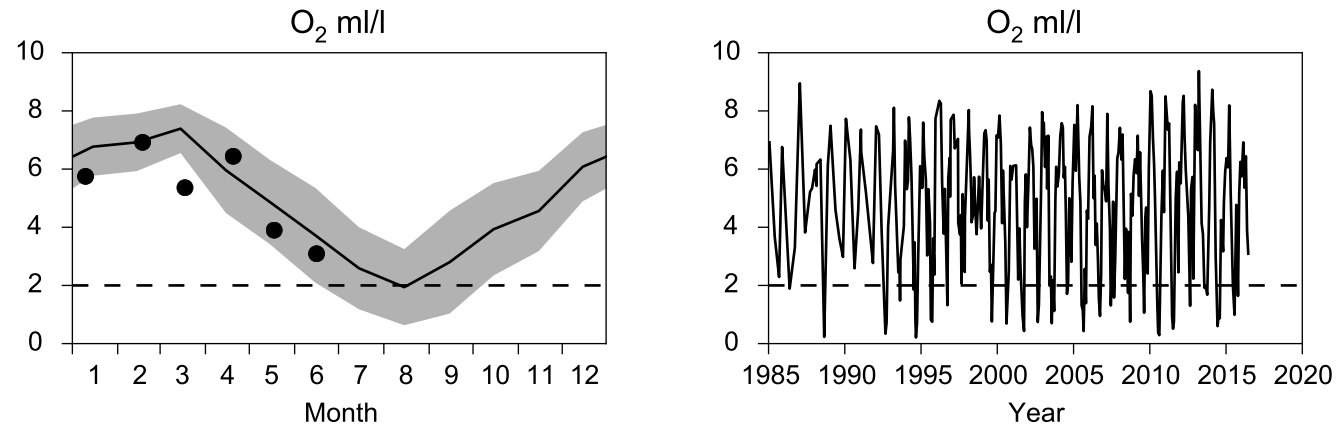
STATION BY1 SURFACE WATER (0-10m)

Annual Cycles

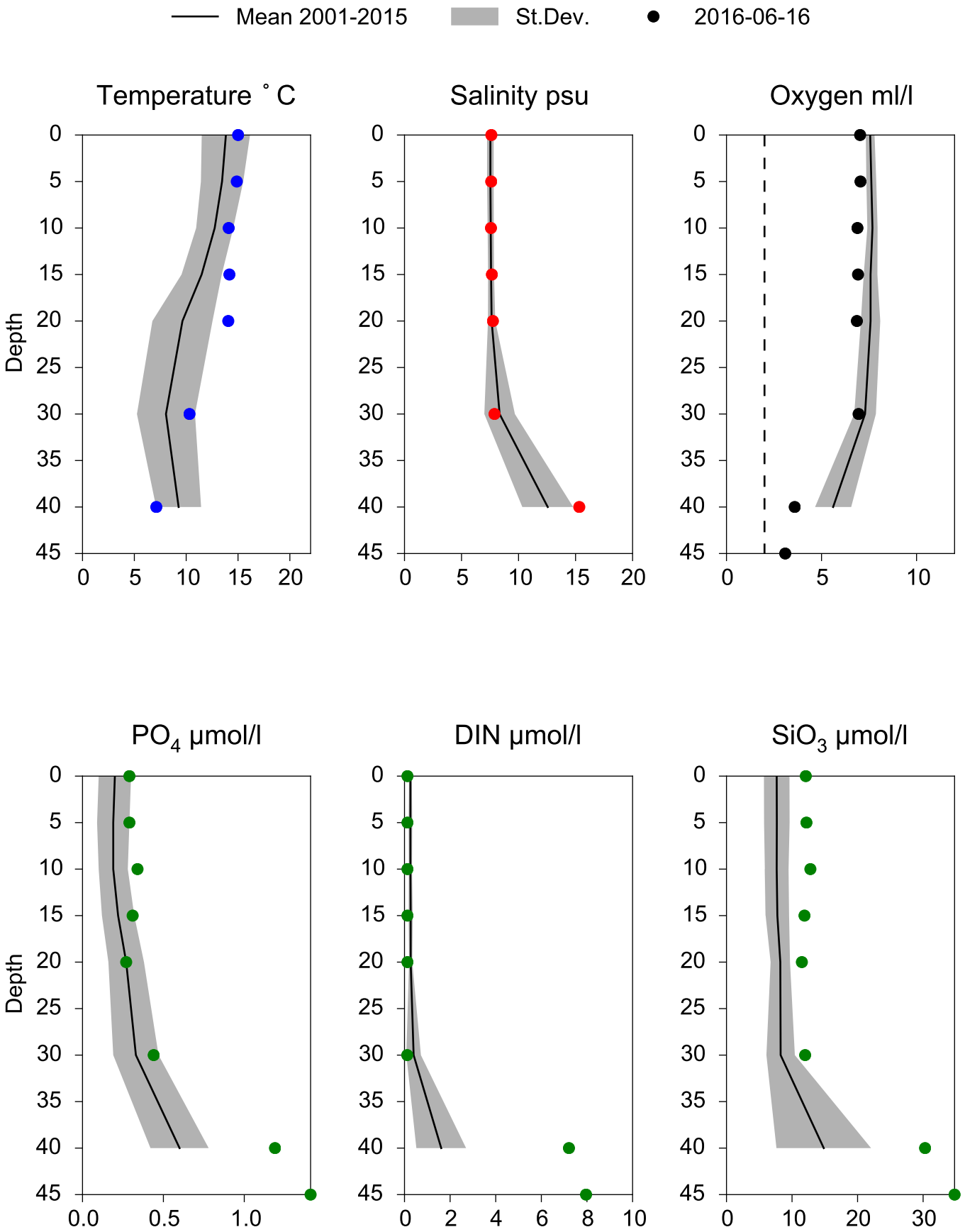
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 40 m)



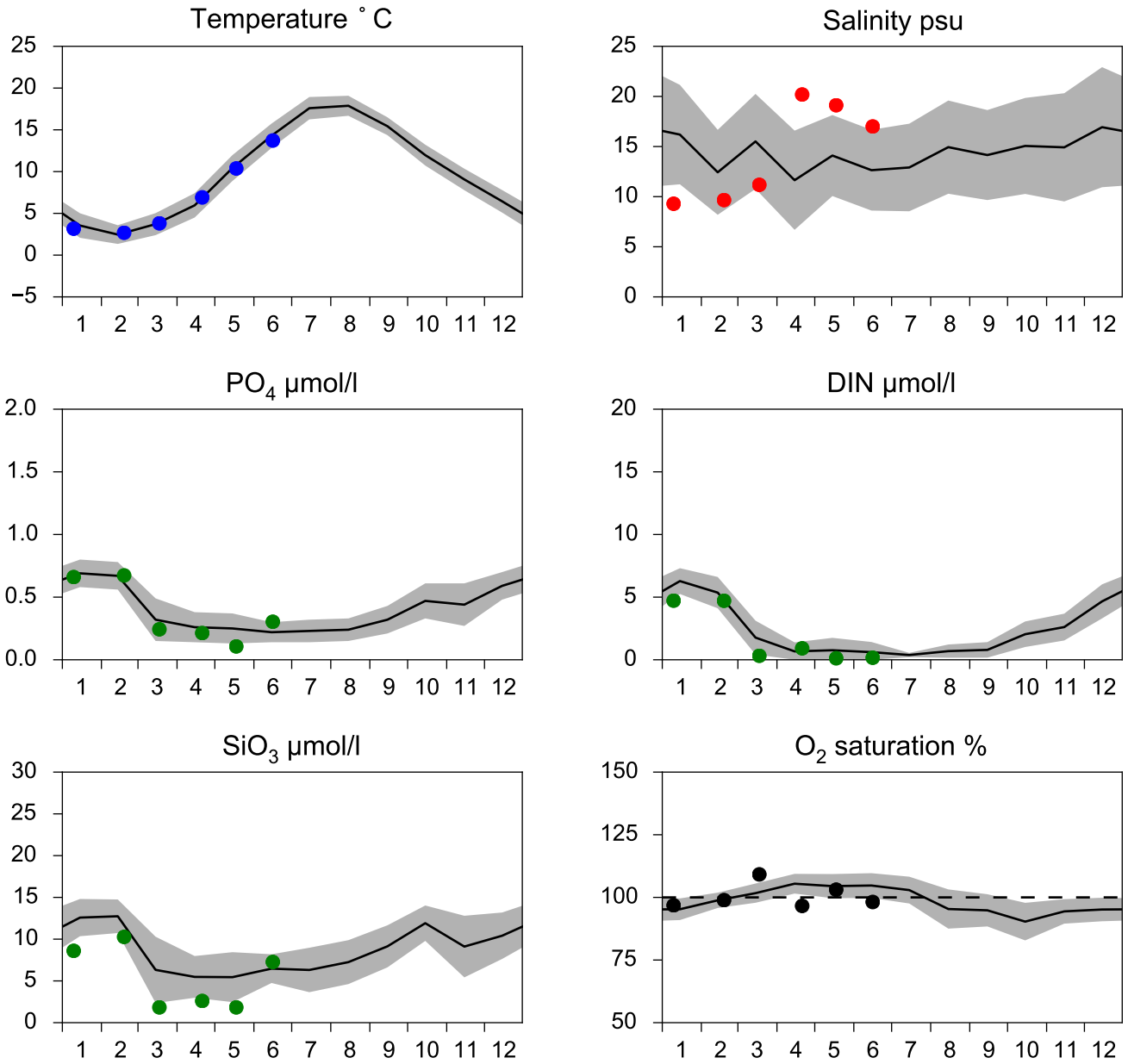
Vertical profiles BY1
June



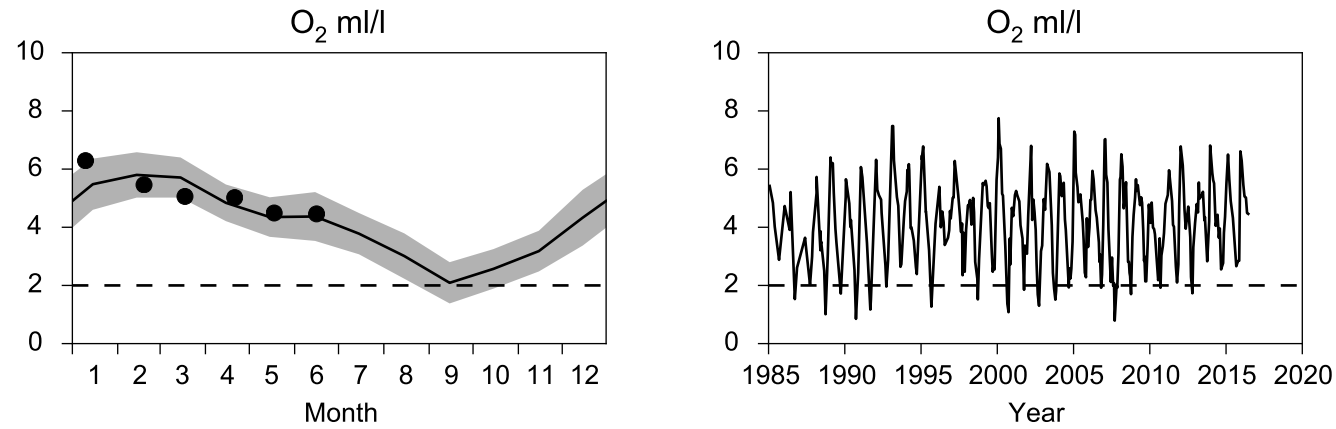
STATION W LANDSKRONA SURFACE WATER (0-10m)

Annual Cycles

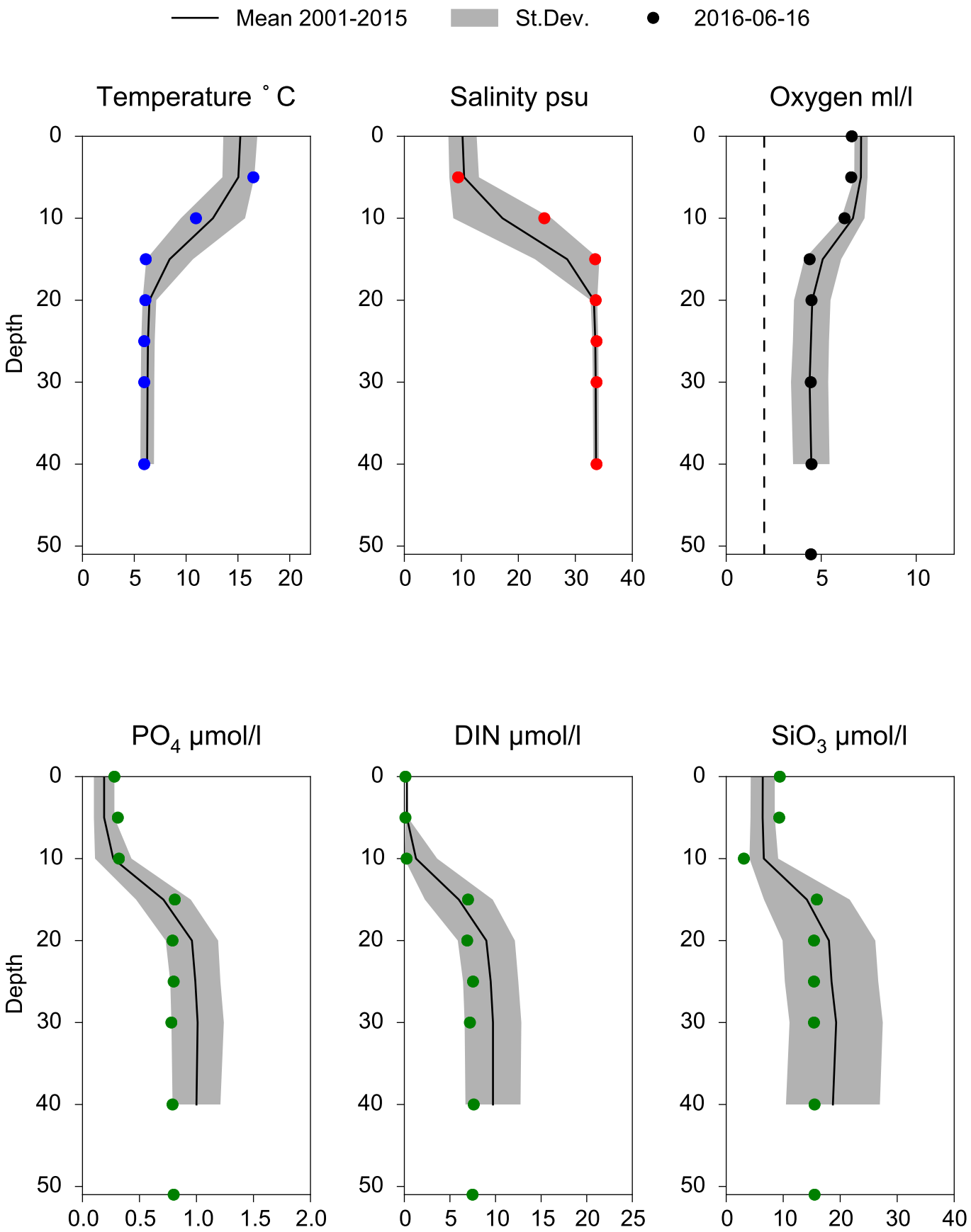
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 40 m)



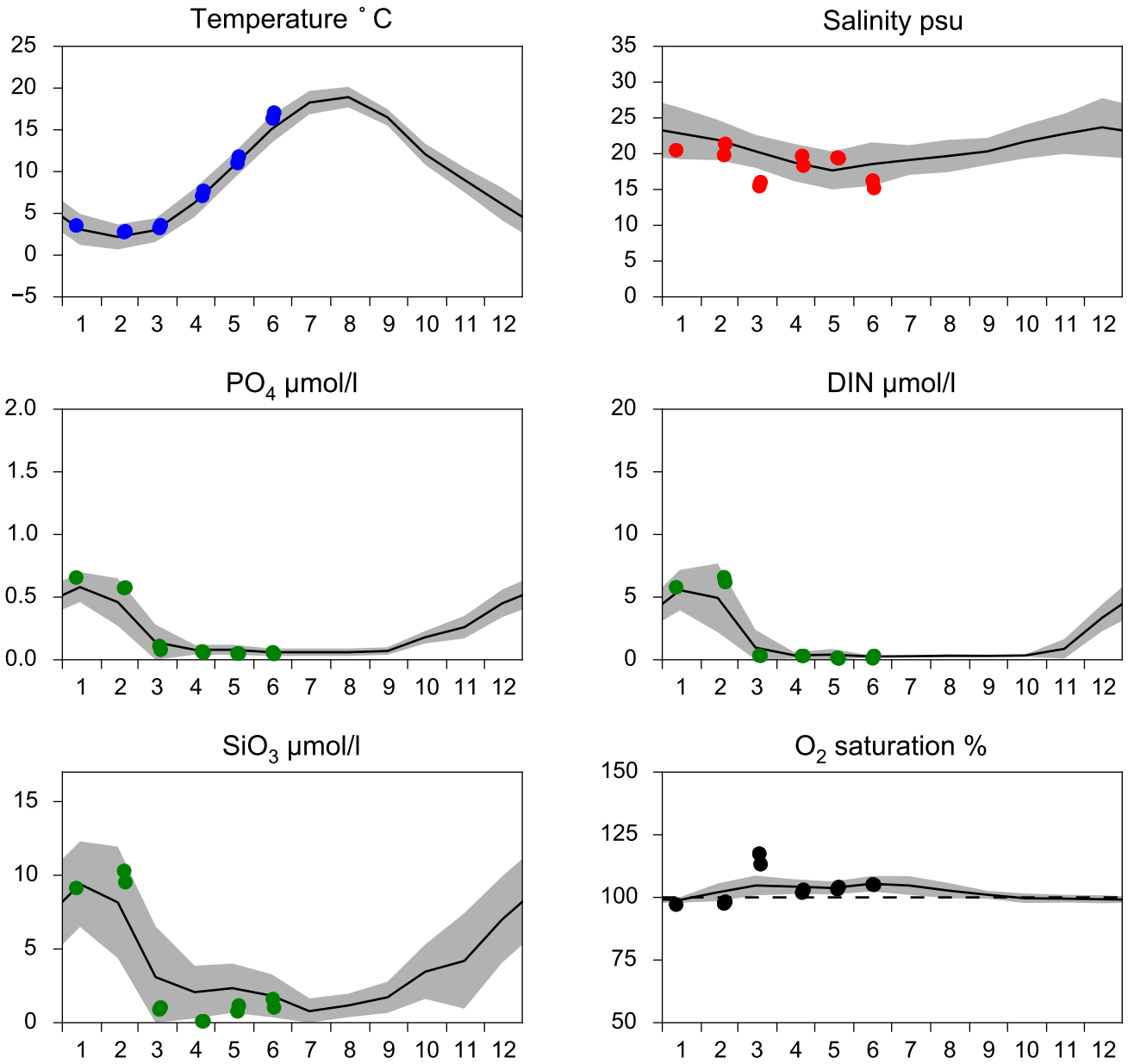
Vertical profiles W LANDSKRONA
June



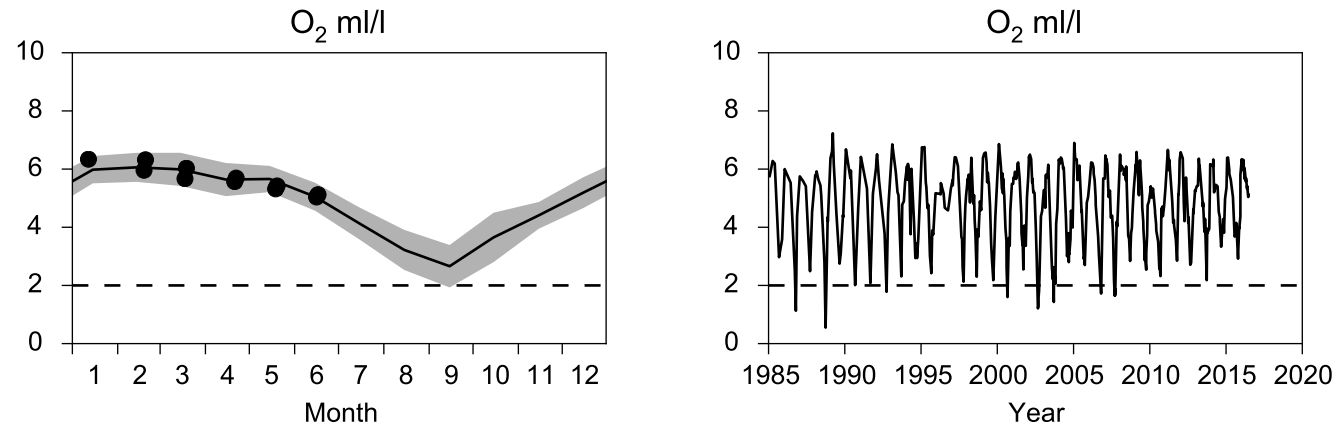
STATION ANHOLT E SURFACE WATER (0-10m)

Annual Cycles

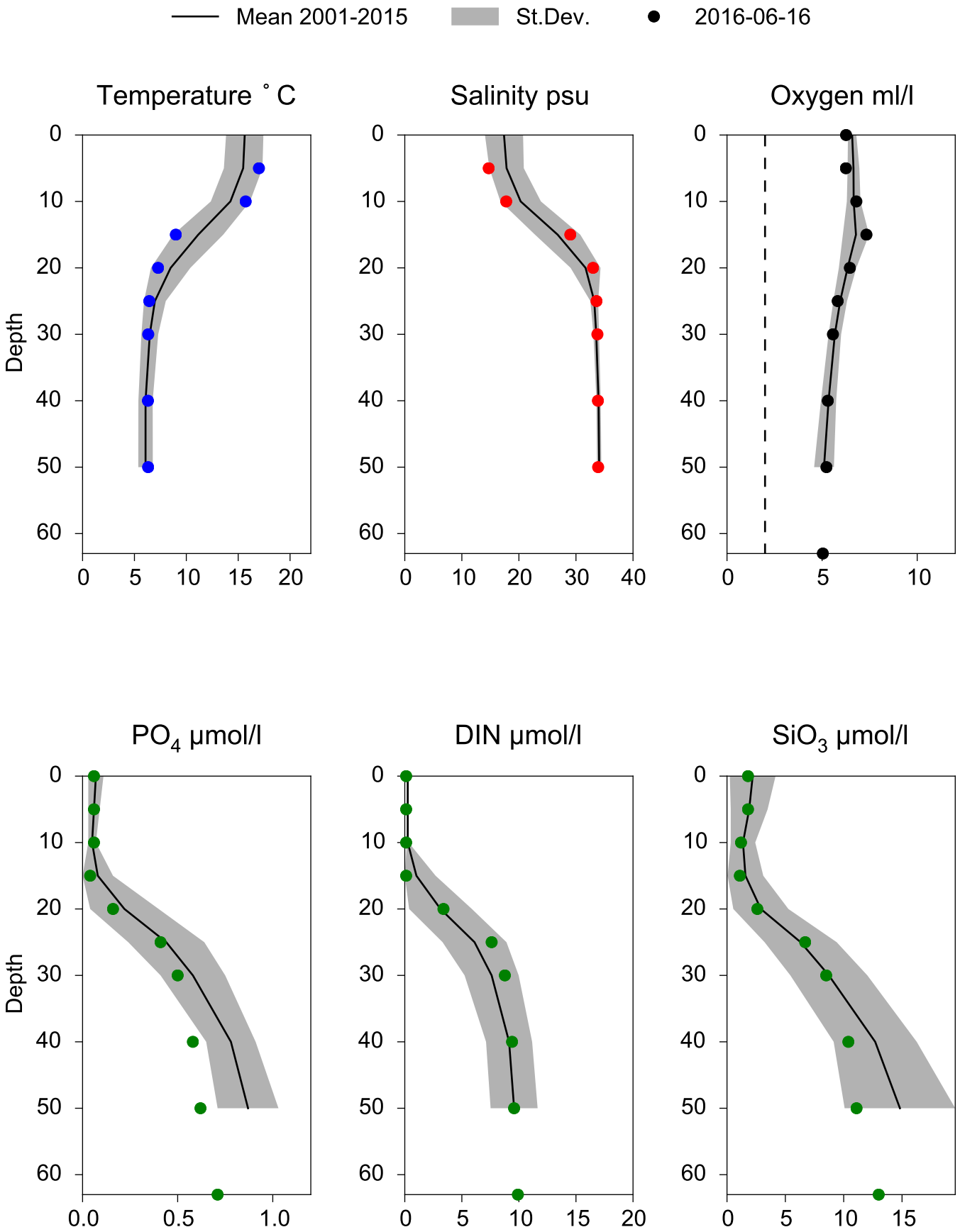
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 45 m)



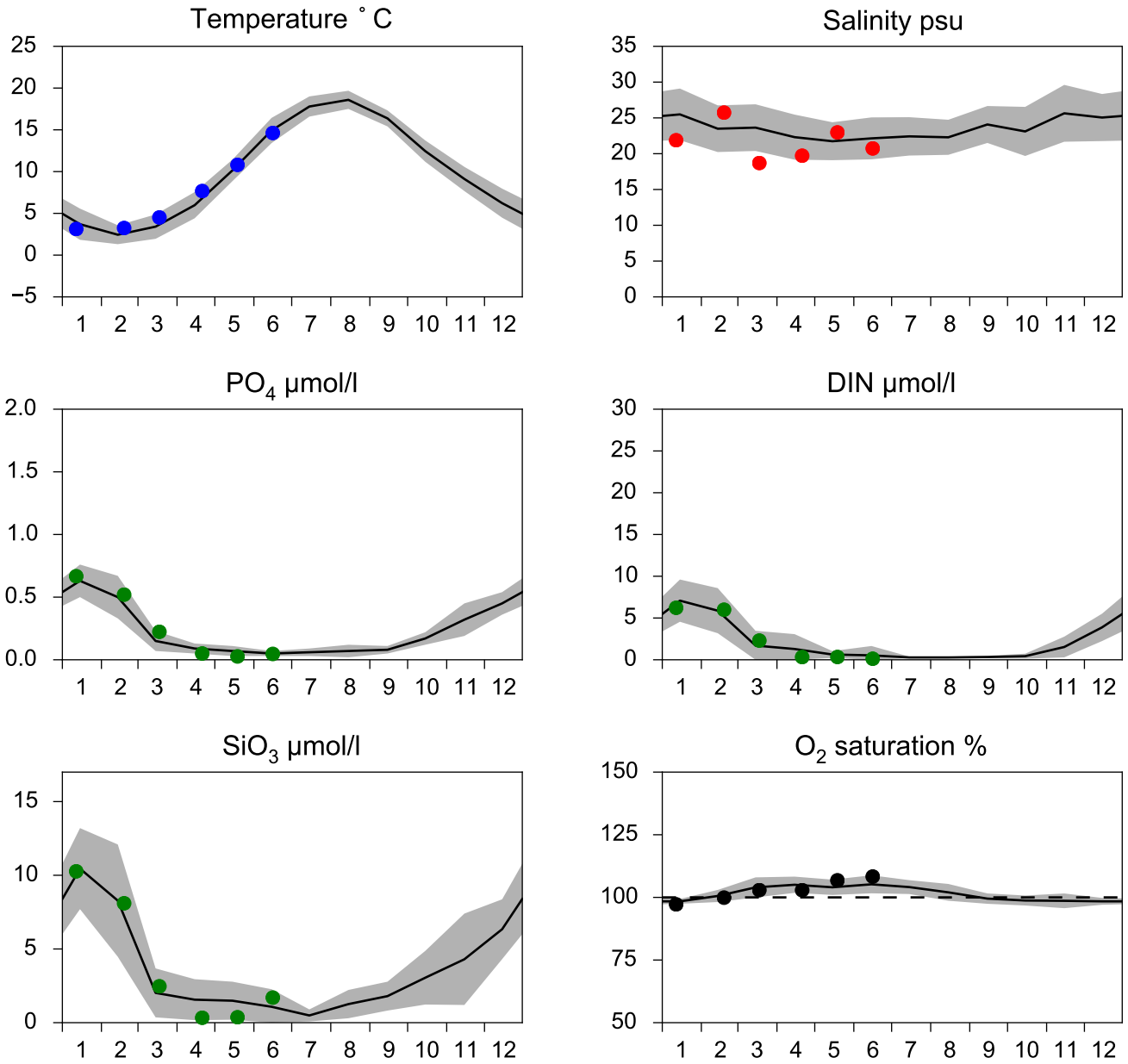
Vertical profiles ANHOLT E
June



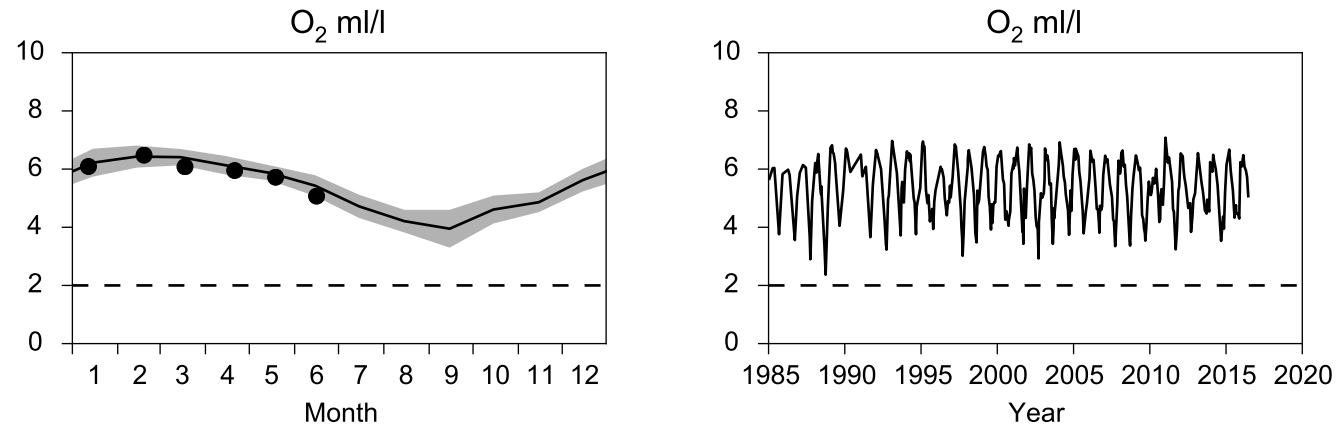
STATION FLADEN SURFACE WATER (0-10m)

Annual Cycles

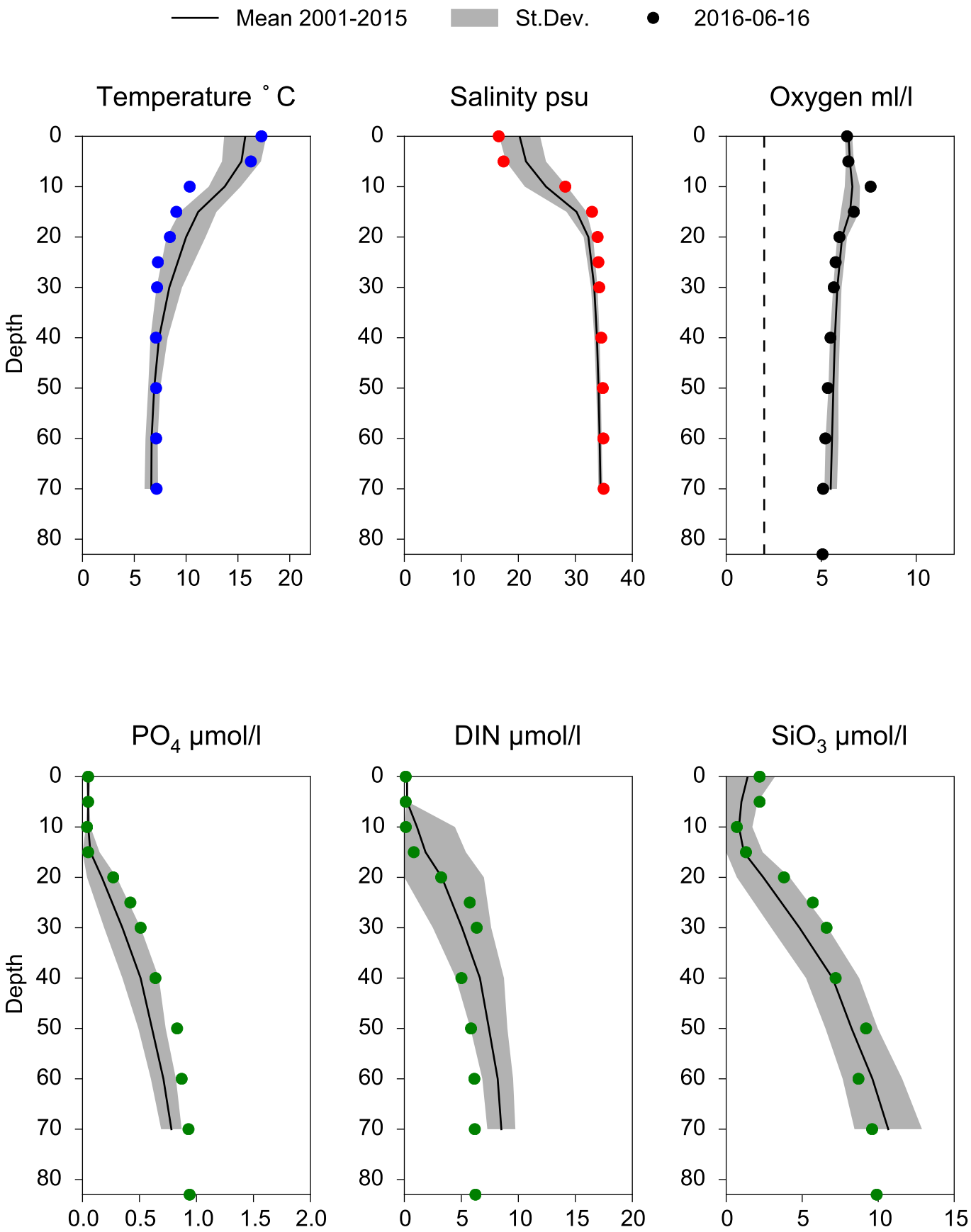
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 65 m)

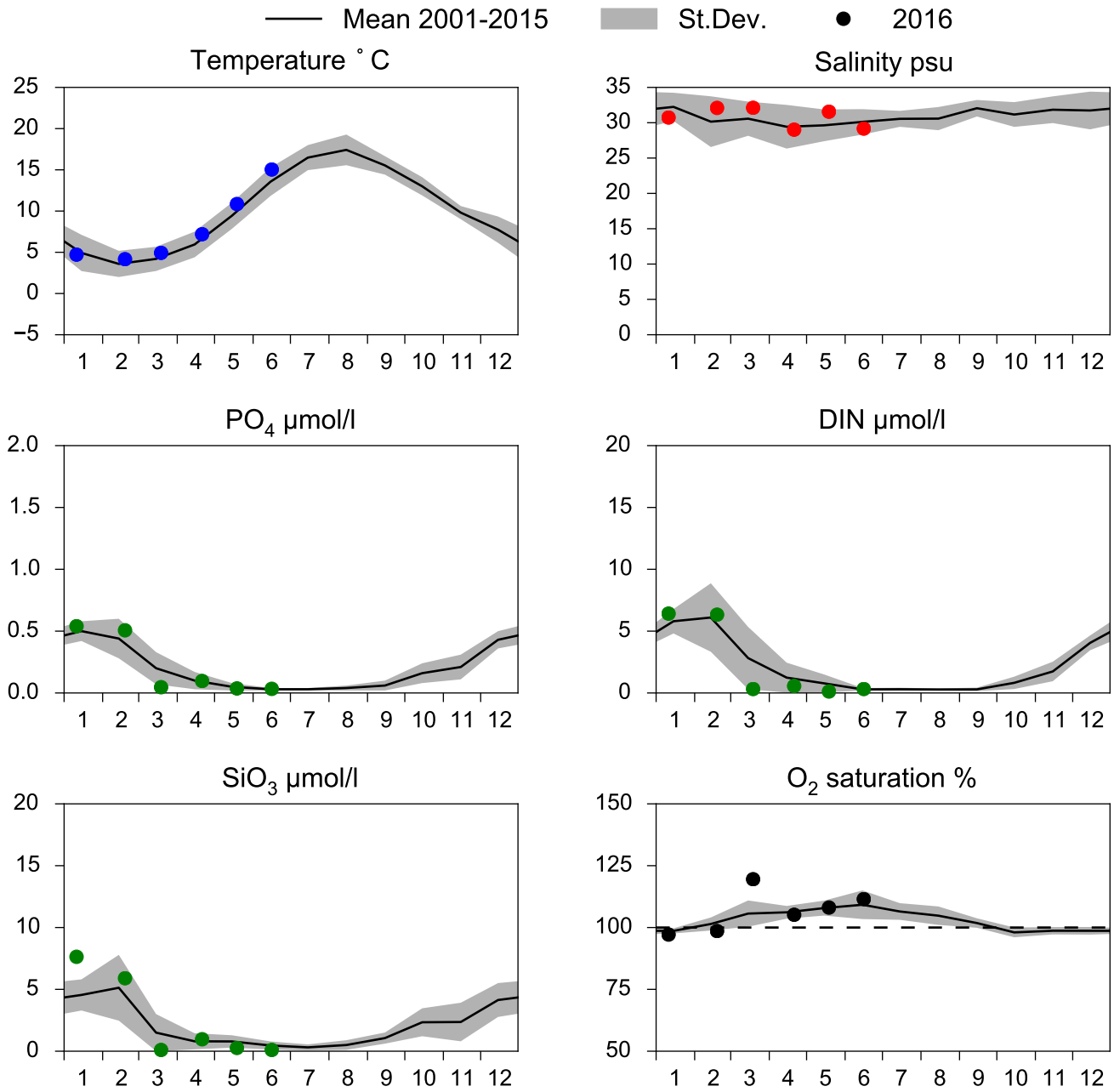


Vertical profiles FLADEN
June

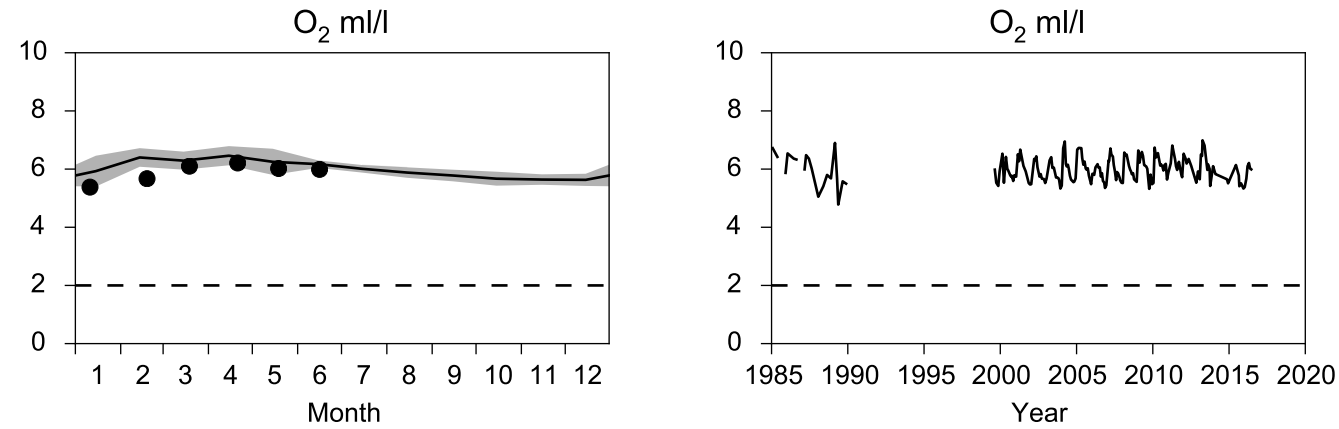


STATION Å17 SURFACE WATER (0-10m)

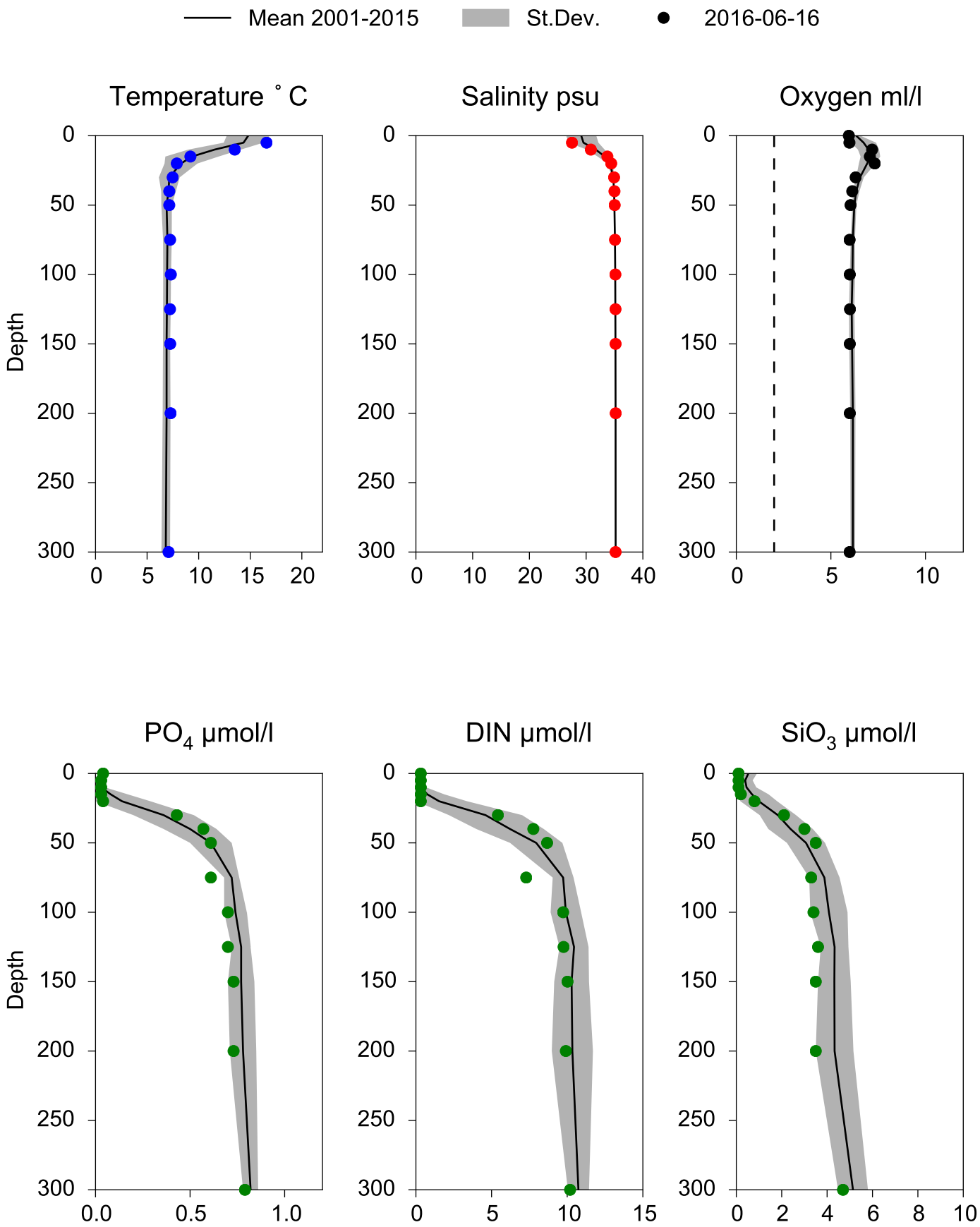
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 300 m)

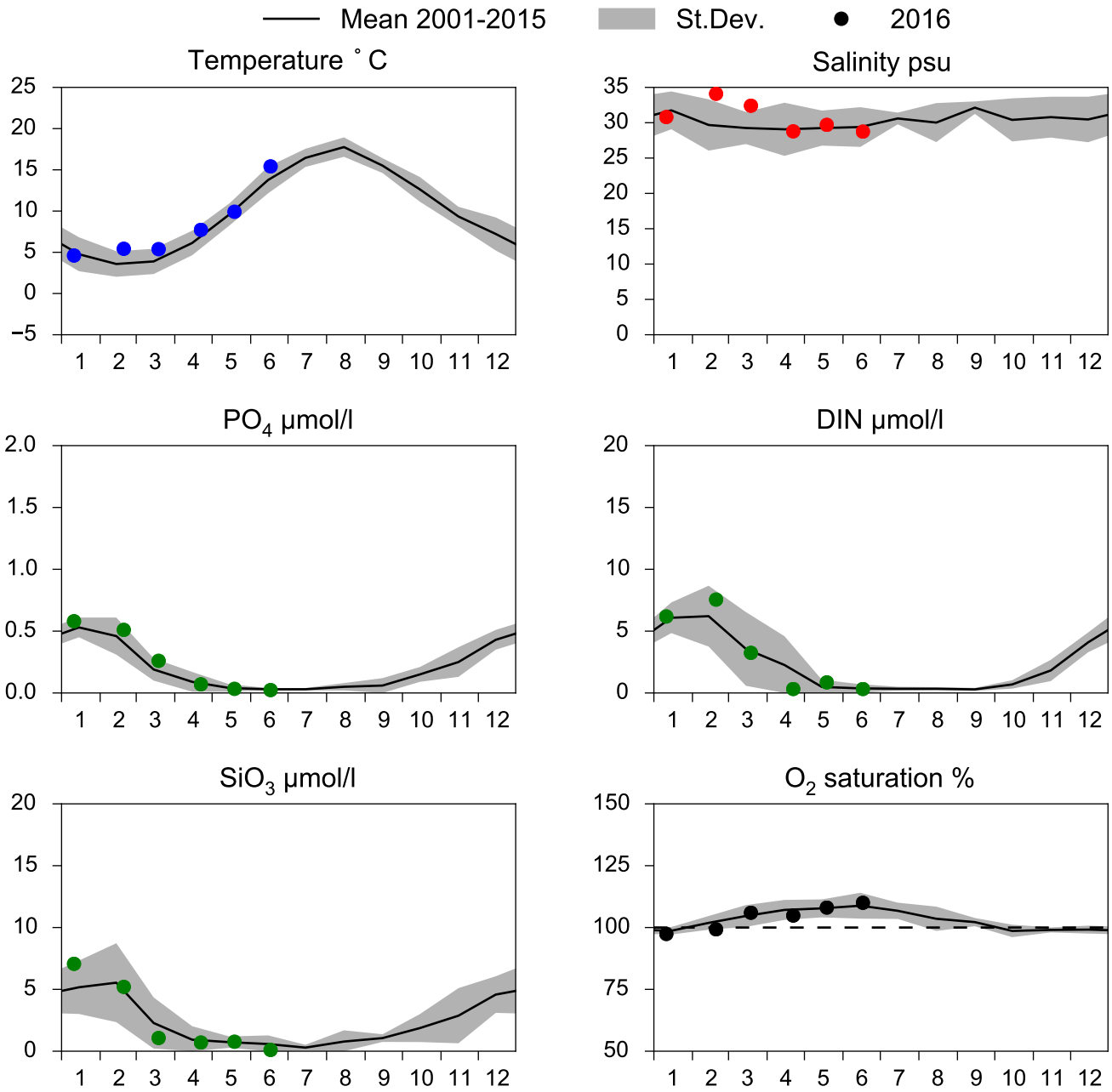


Vertical profiles Å17
June

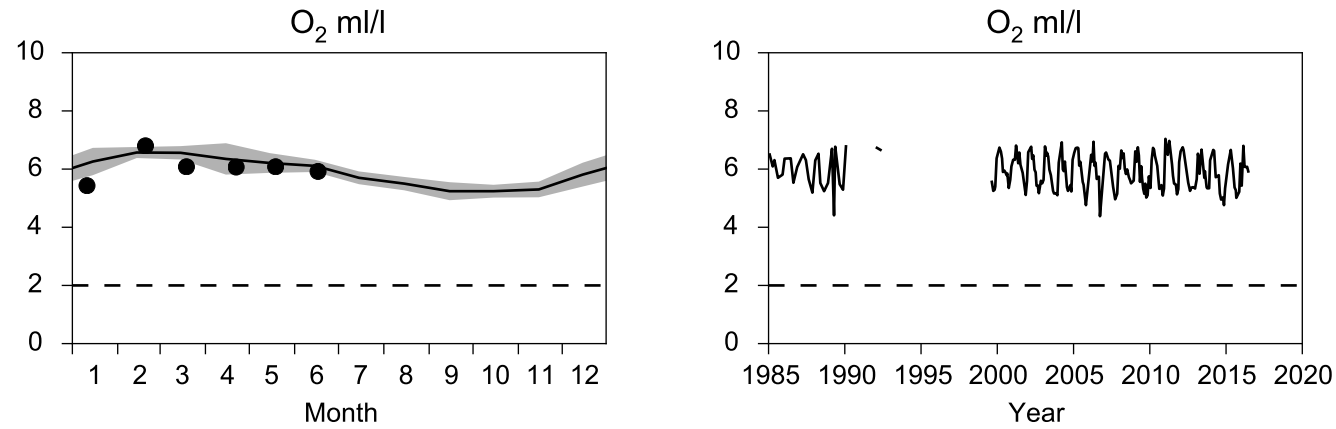


STATION Å15 SURFACE WATER (0-10m)

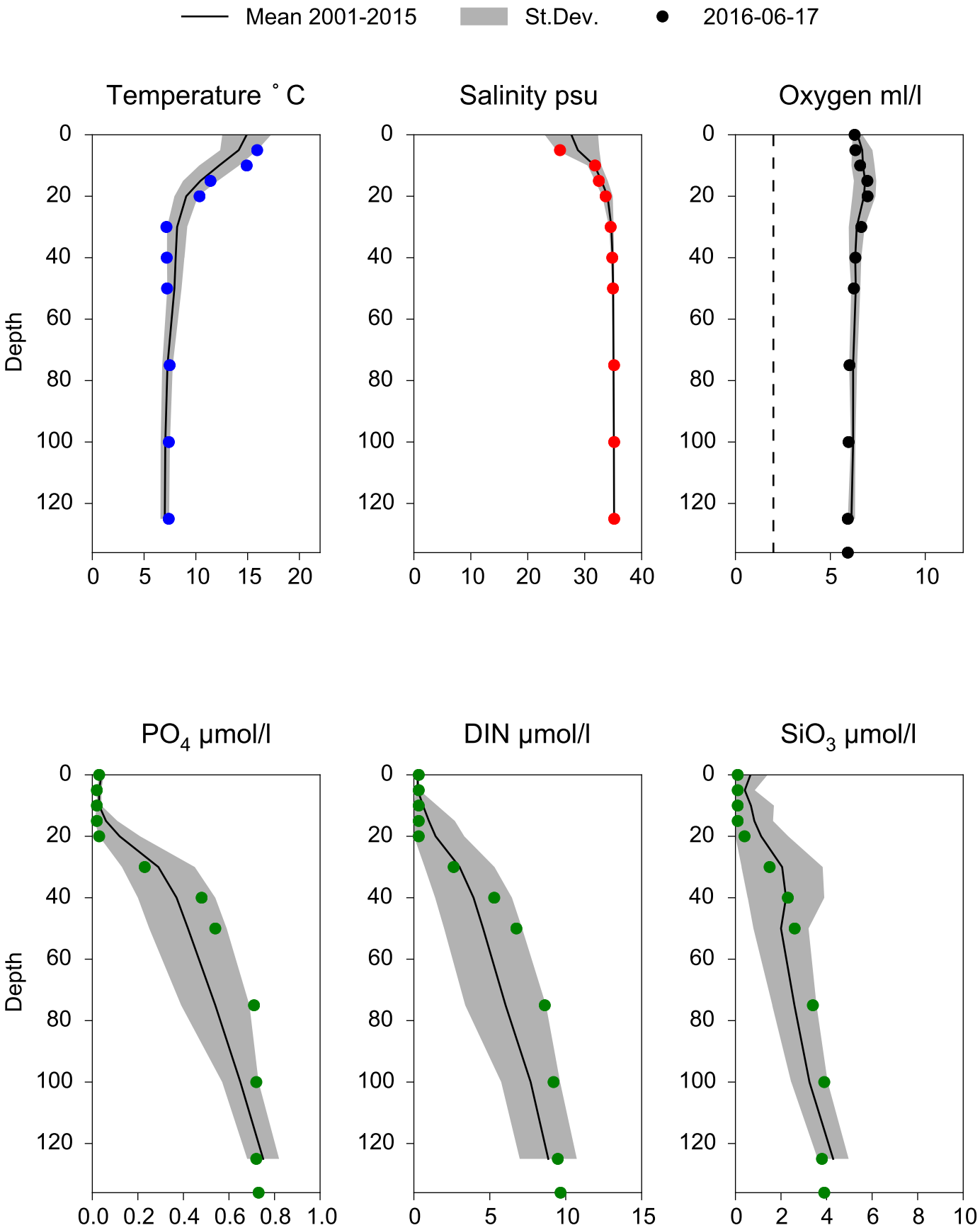
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)



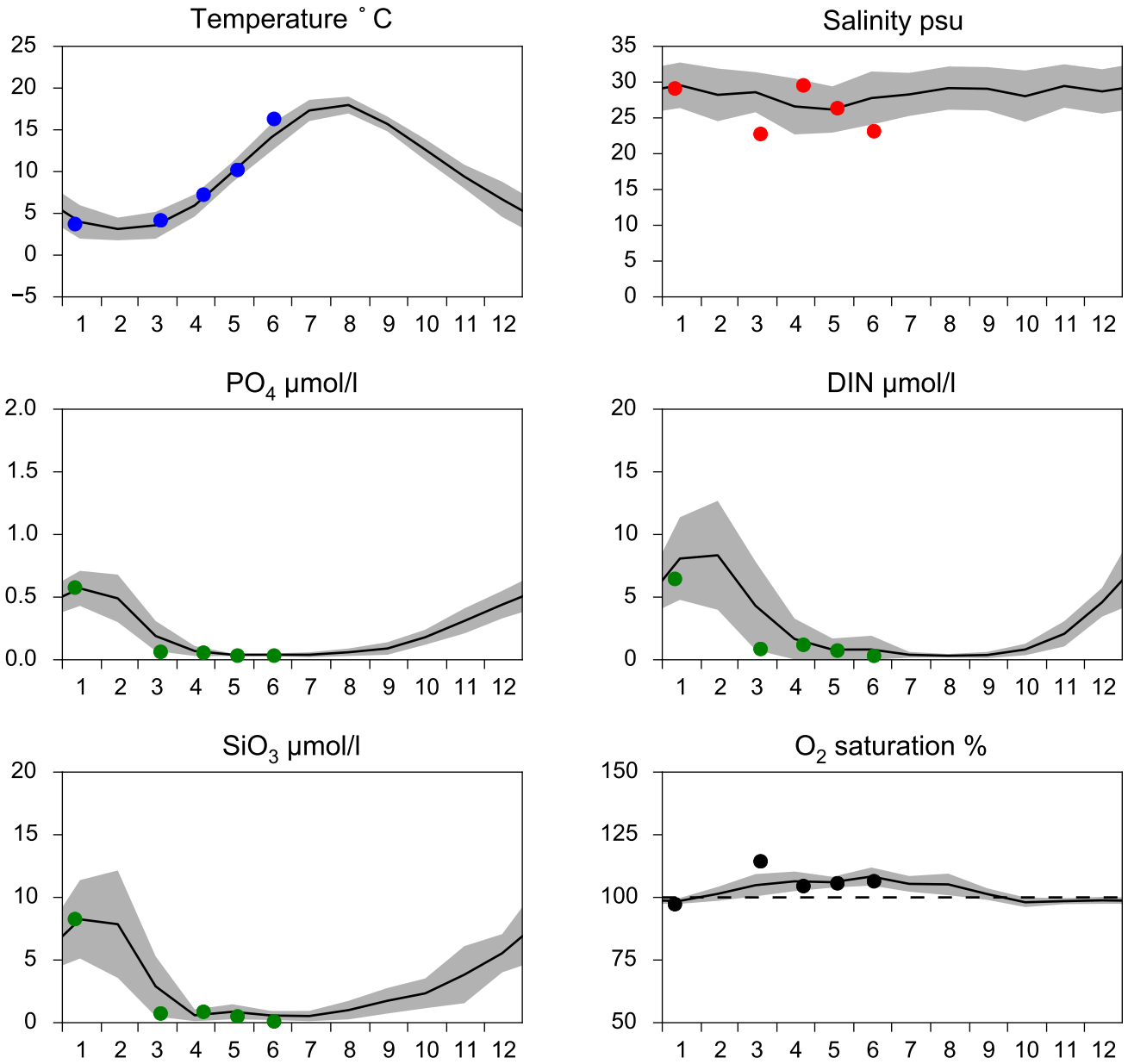
Vertical profiles Å15
June



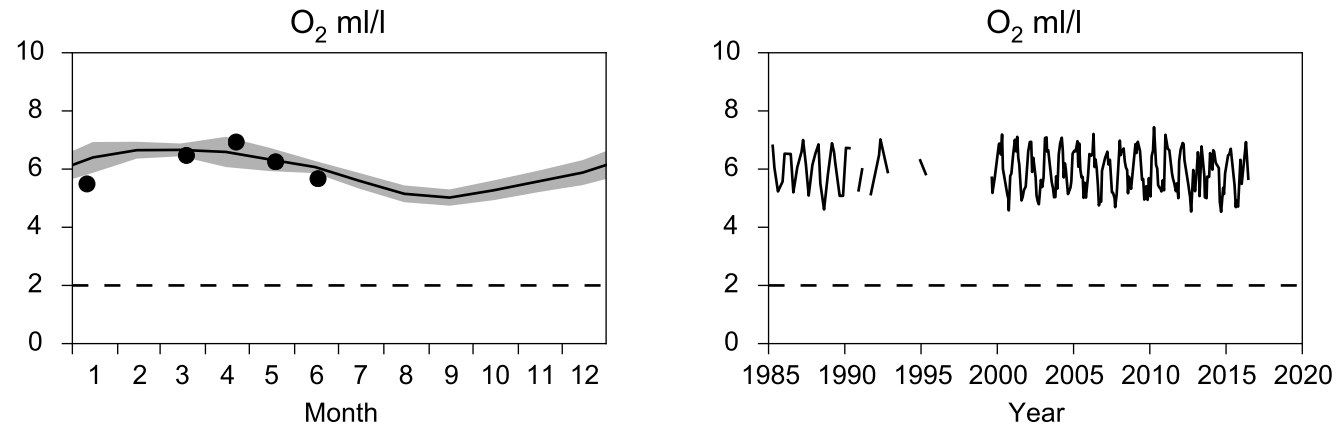
STATION Å13 SURFACE WATER (0-10m)

Annual Cycles

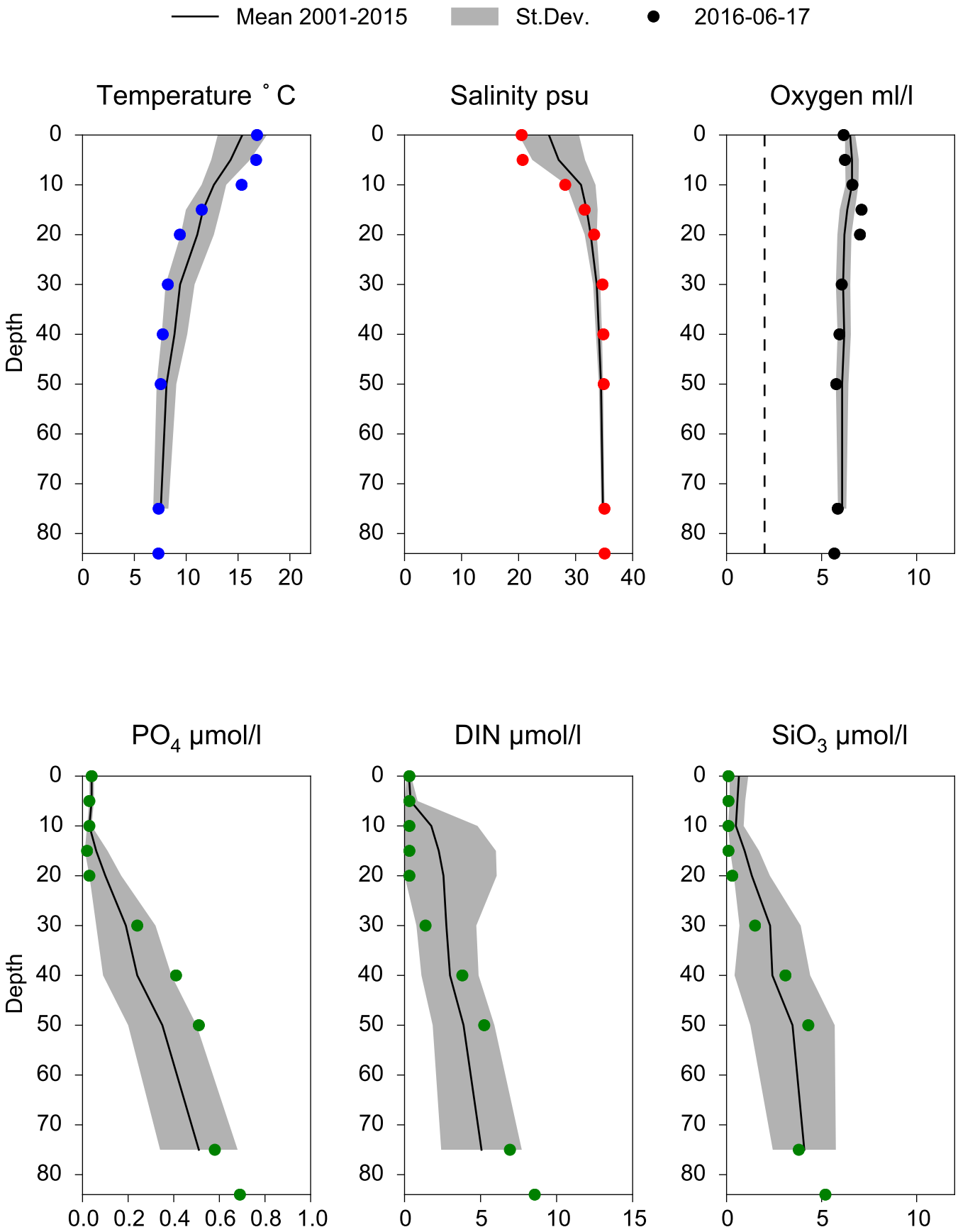
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 75 m)



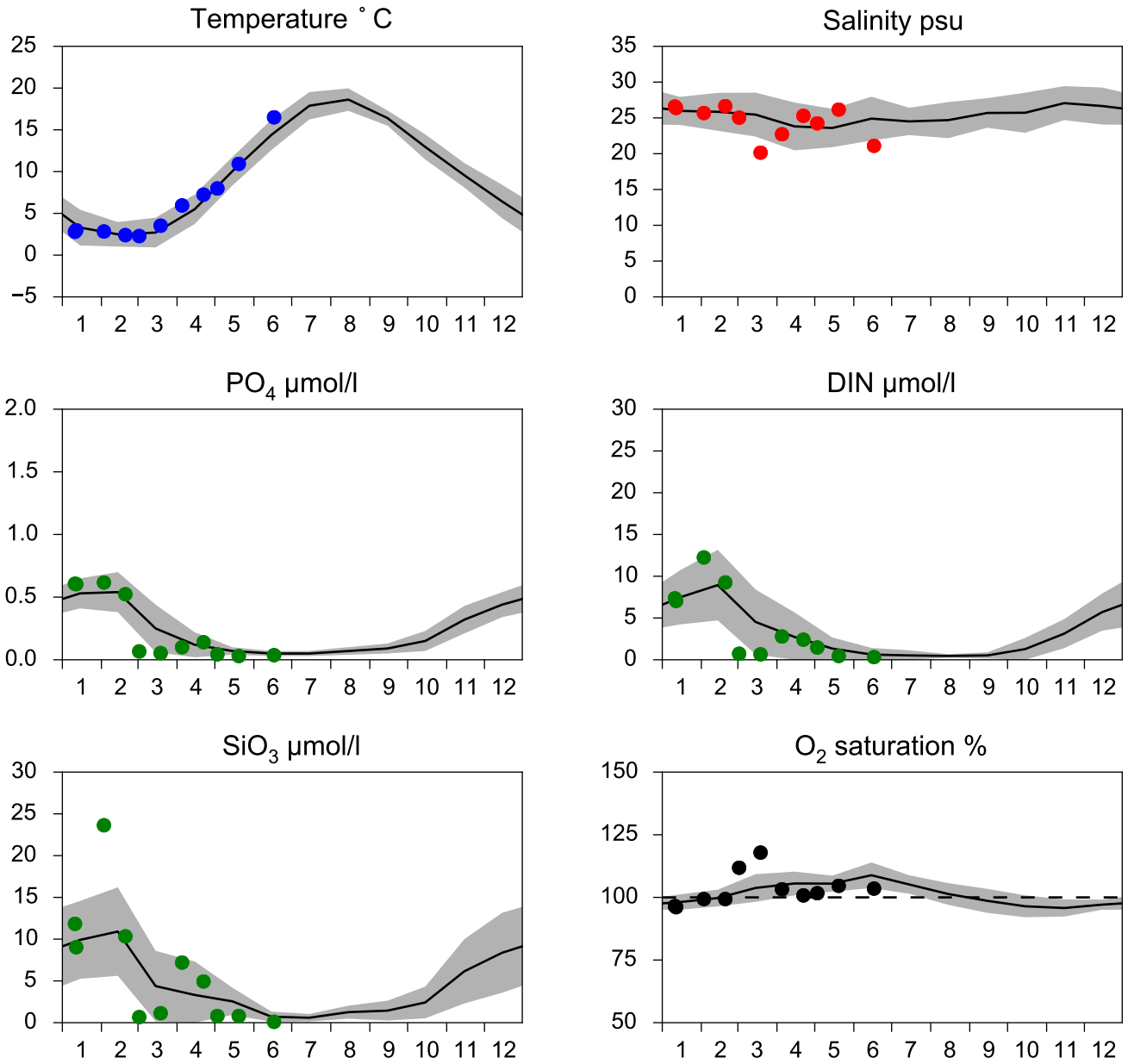
Vertical profiles Å13
June



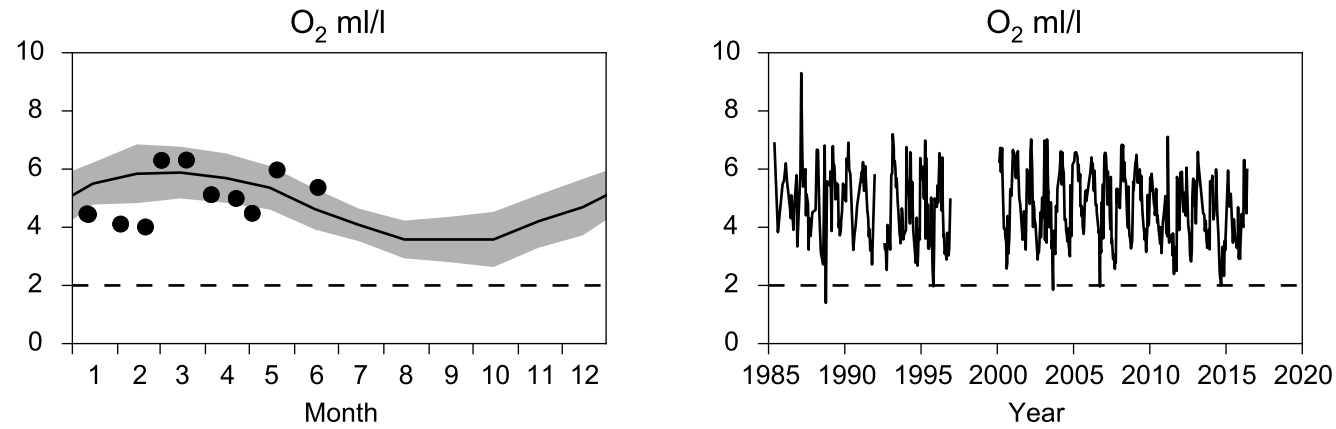
STATION SLÄGGÖ SURFACE WATER (0-10m)

Annual Cycles

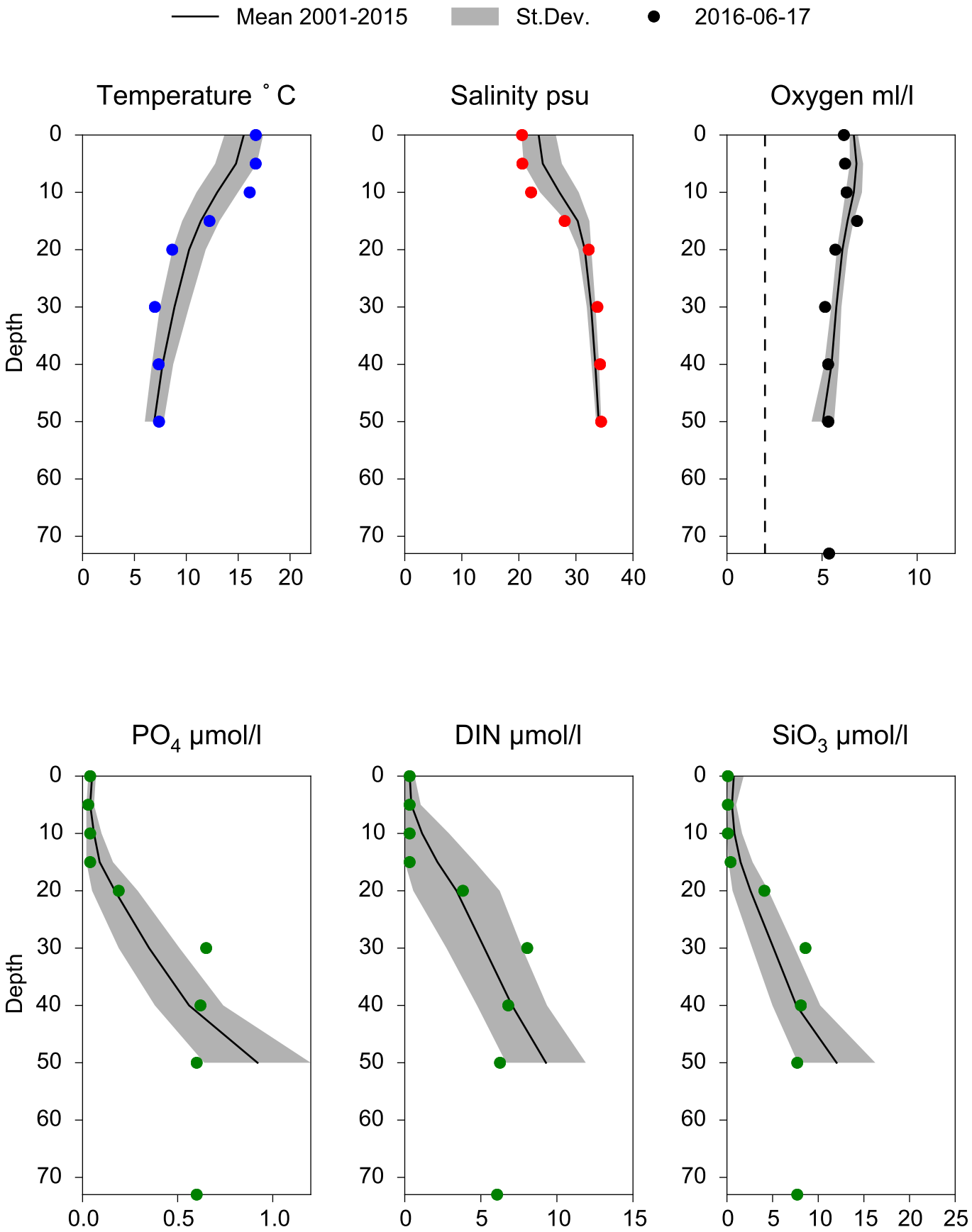
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 50 m)



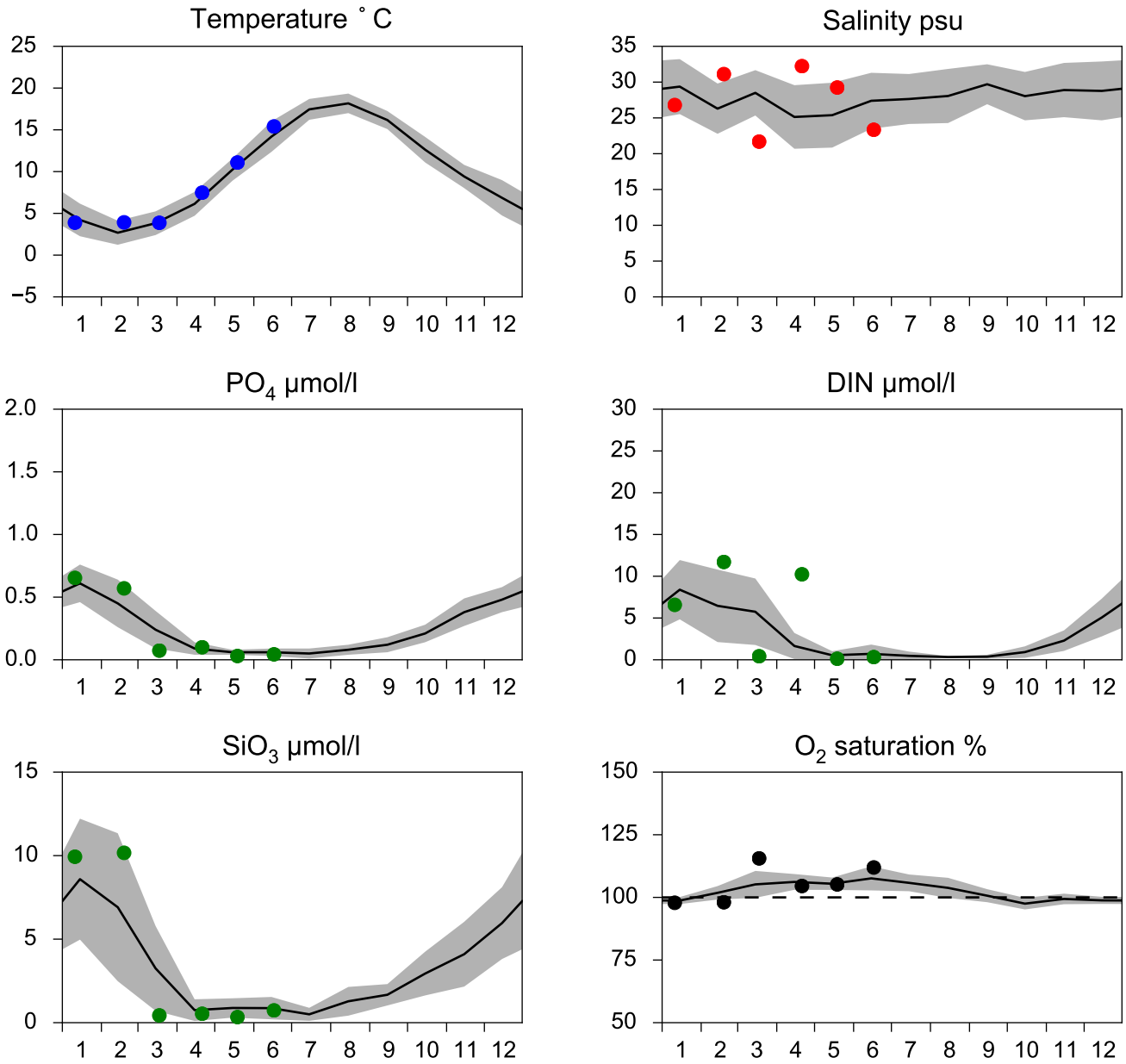
Vertical profiles SLÄGGÖ
June



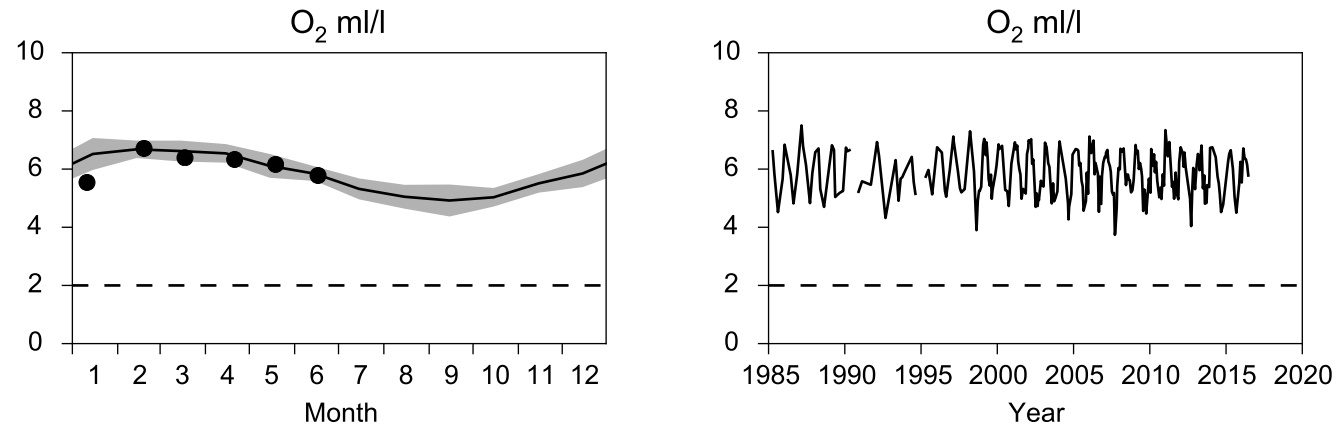
STATION P2 SURFACE WATER (0-10m)

Annual Cycles

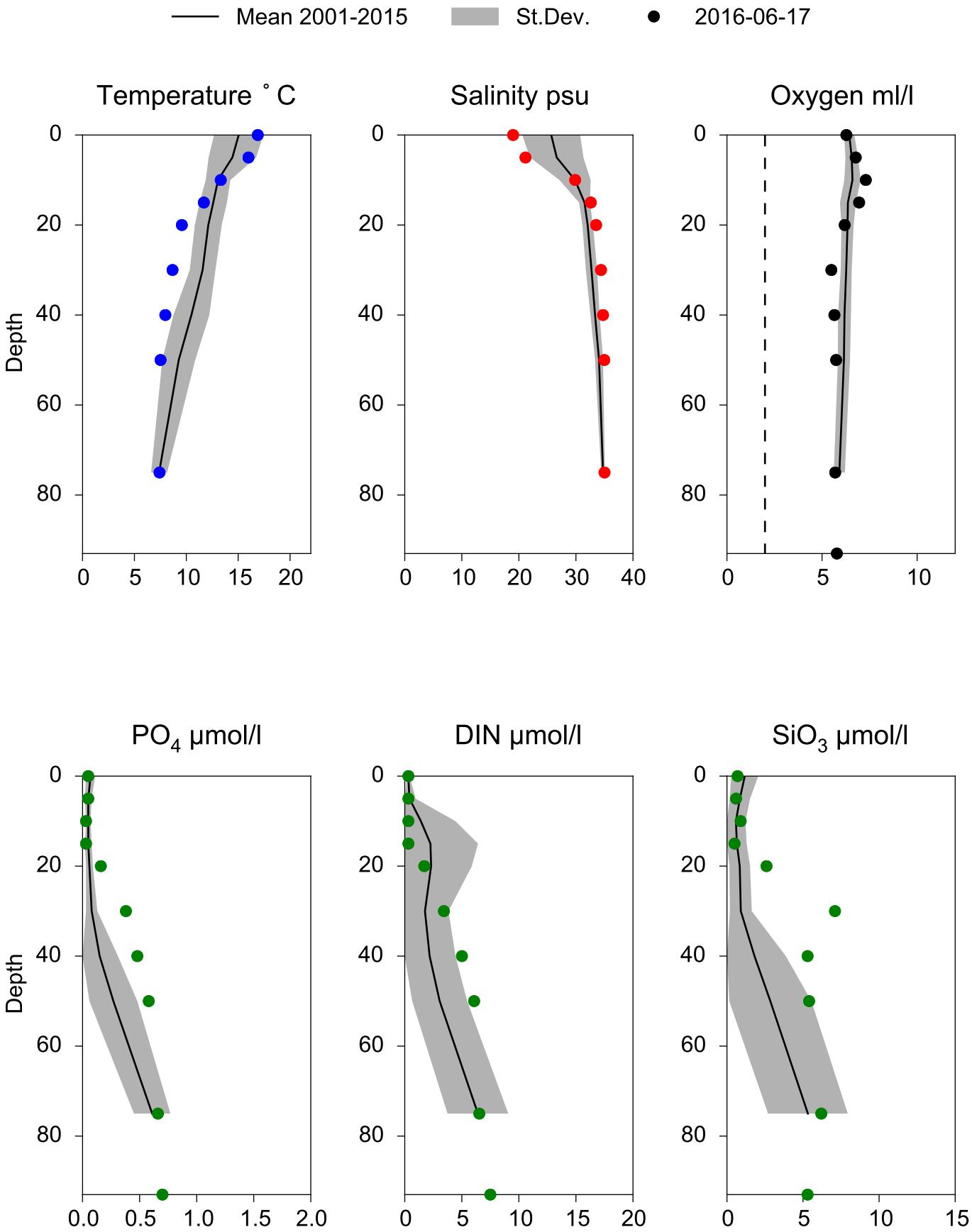
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 80 m)



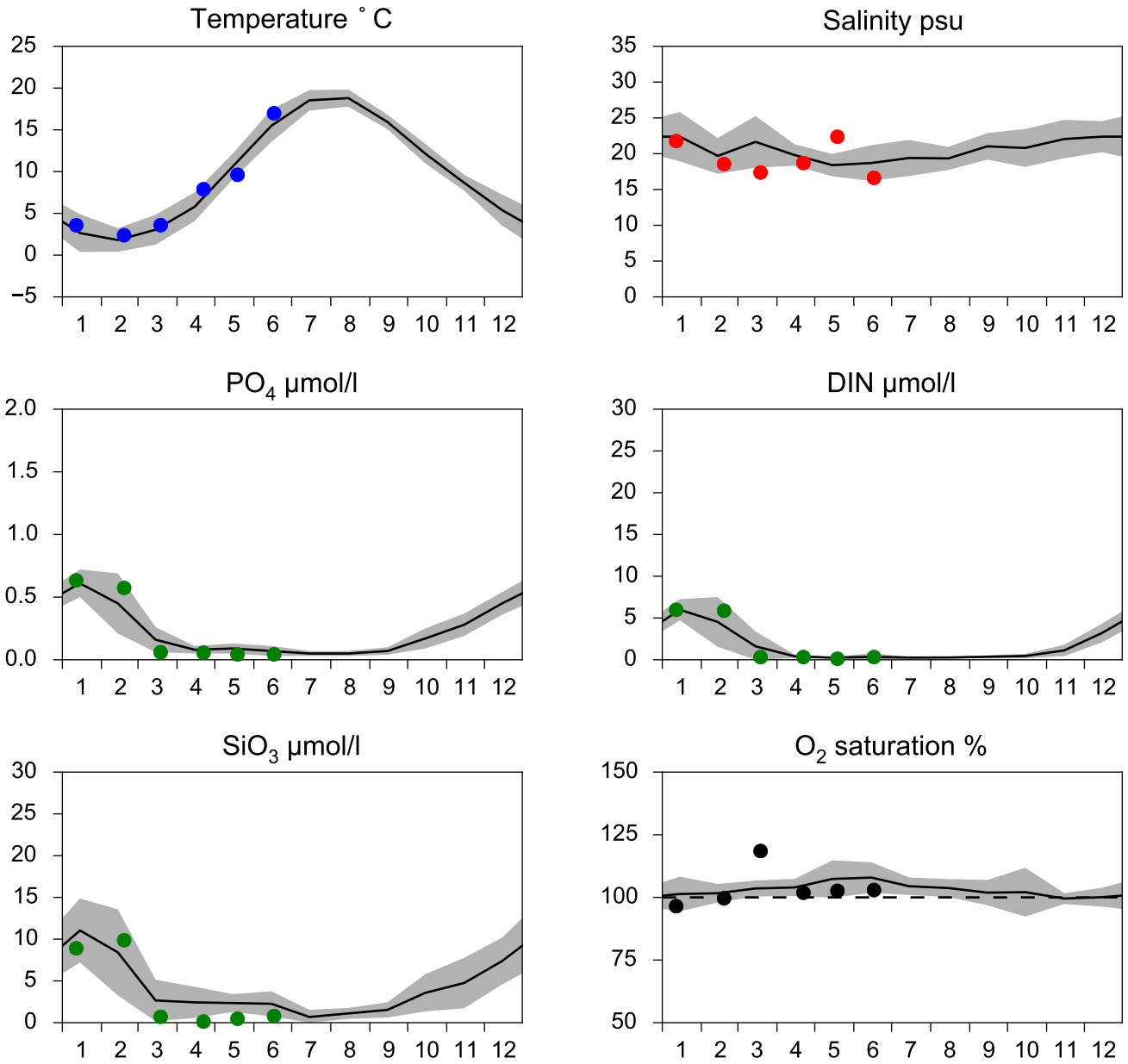
Vertical profiles P2
June



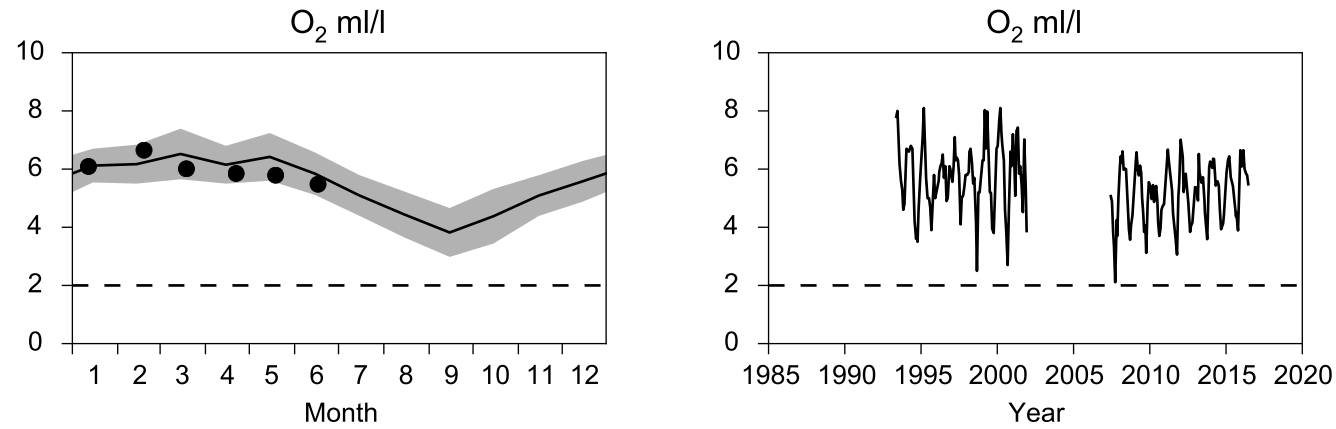
STATION N14 FALKENBERG SURFACE WATER (0-10m)

Annual Cycles

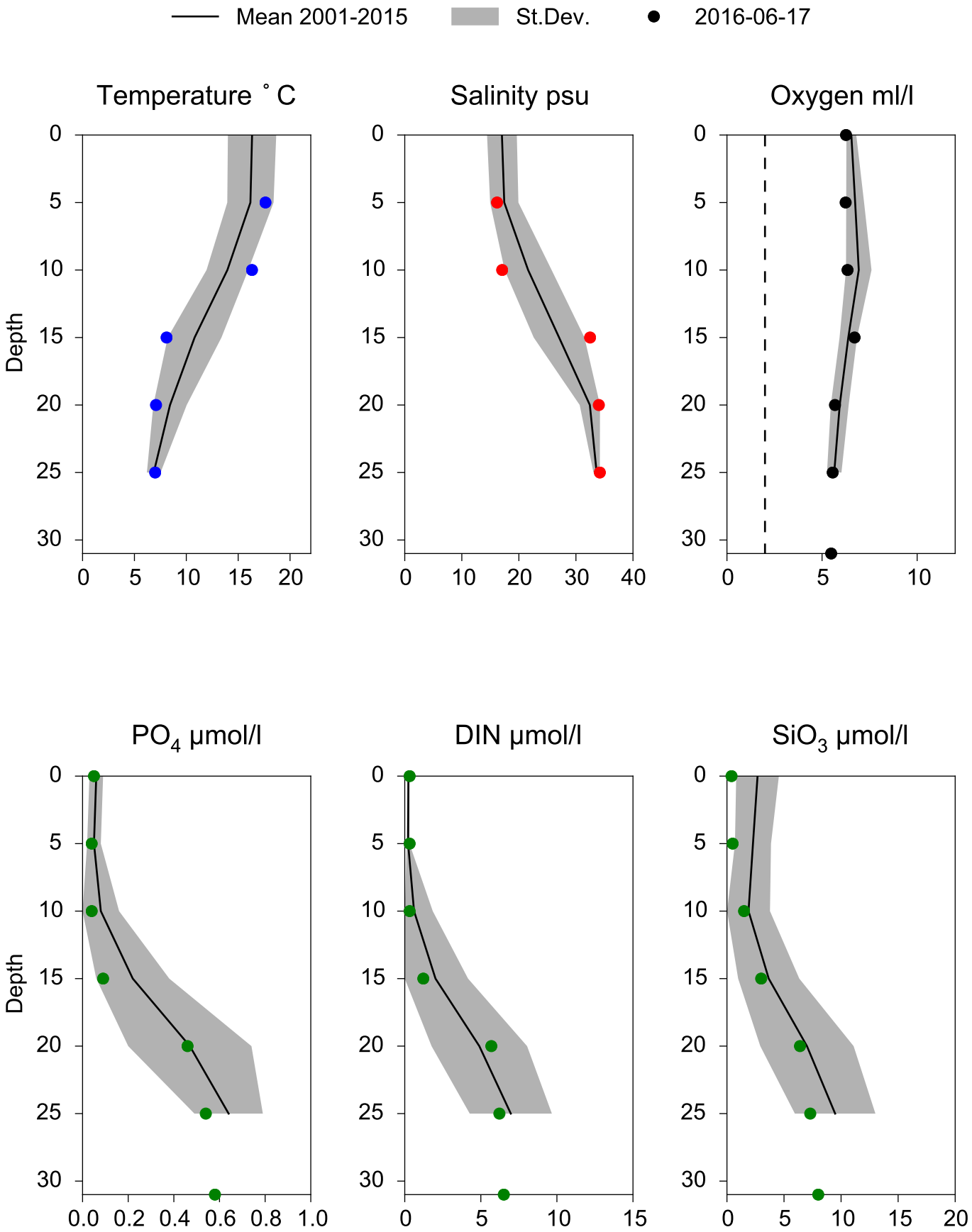
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 25 m)



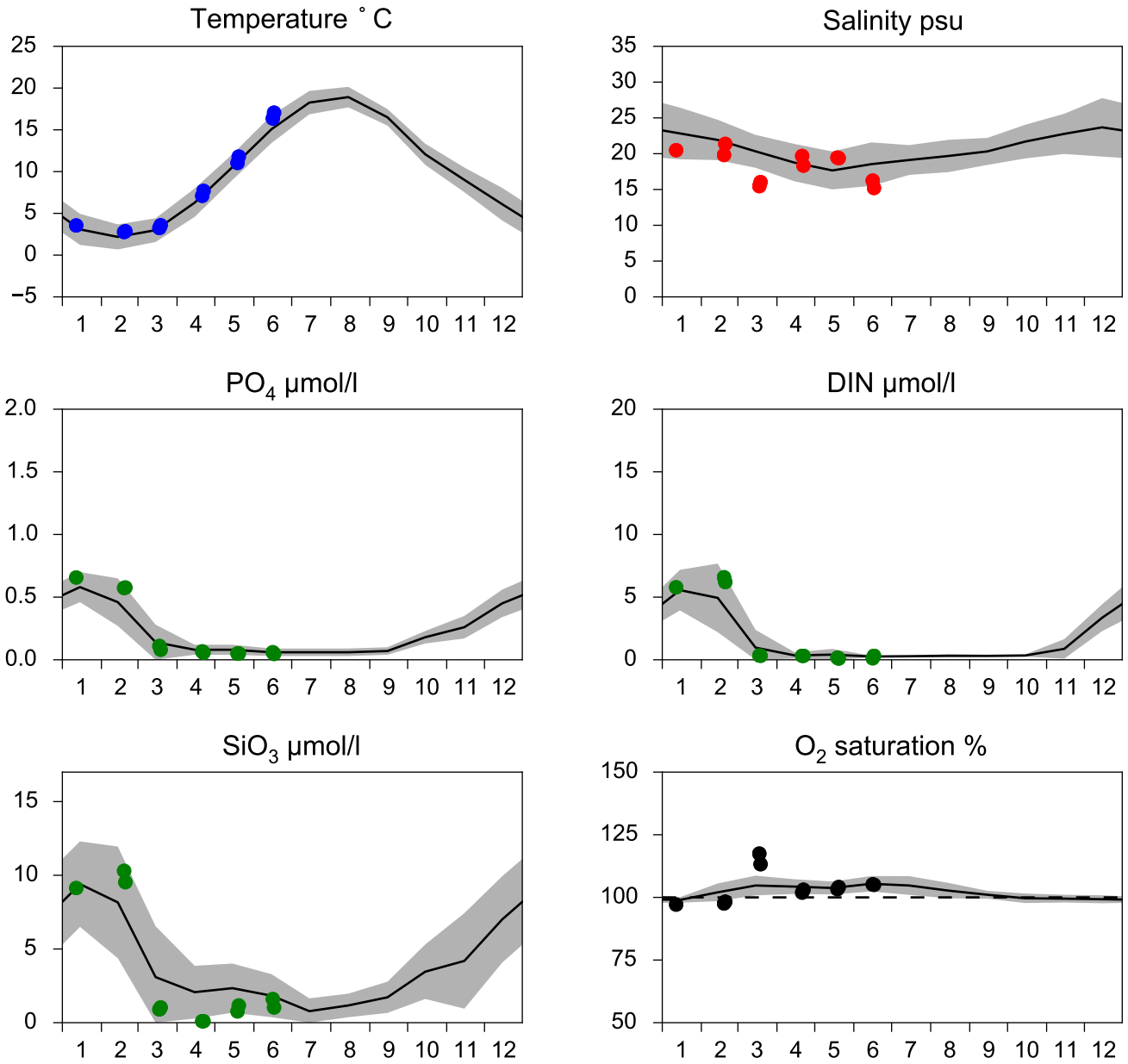
Vertical profiles N14 FALKENBERG
June



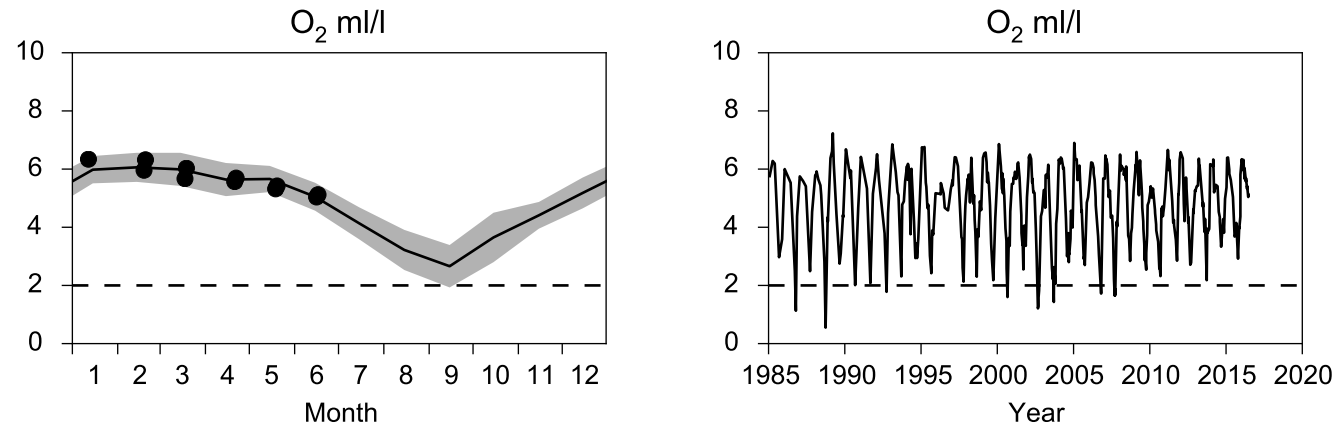
STATION ANHOLT E SURFACE WATER (0-10m)

Annual Cycles

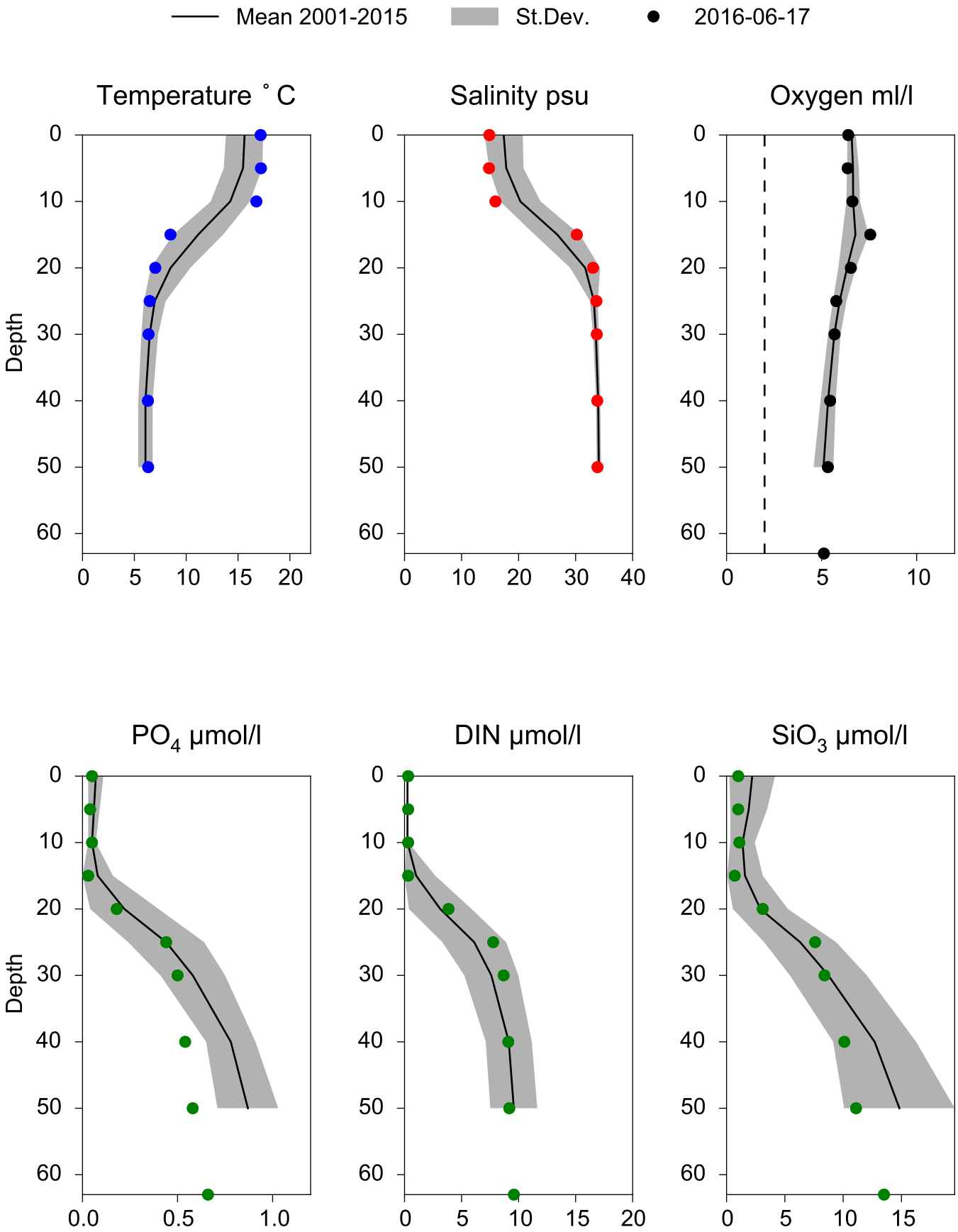
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 45 m)

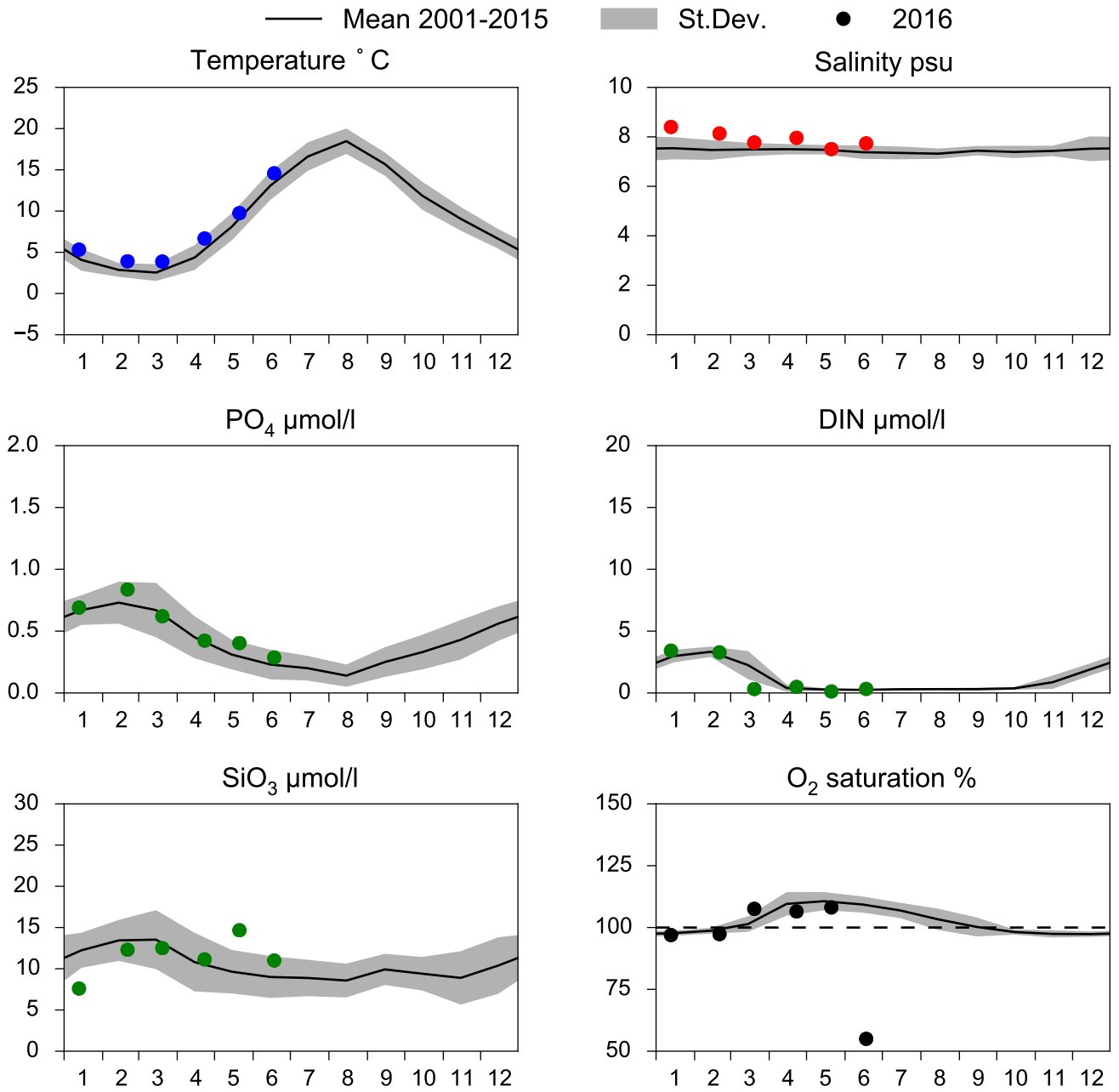


Vertical profiles ANHOLT E
June

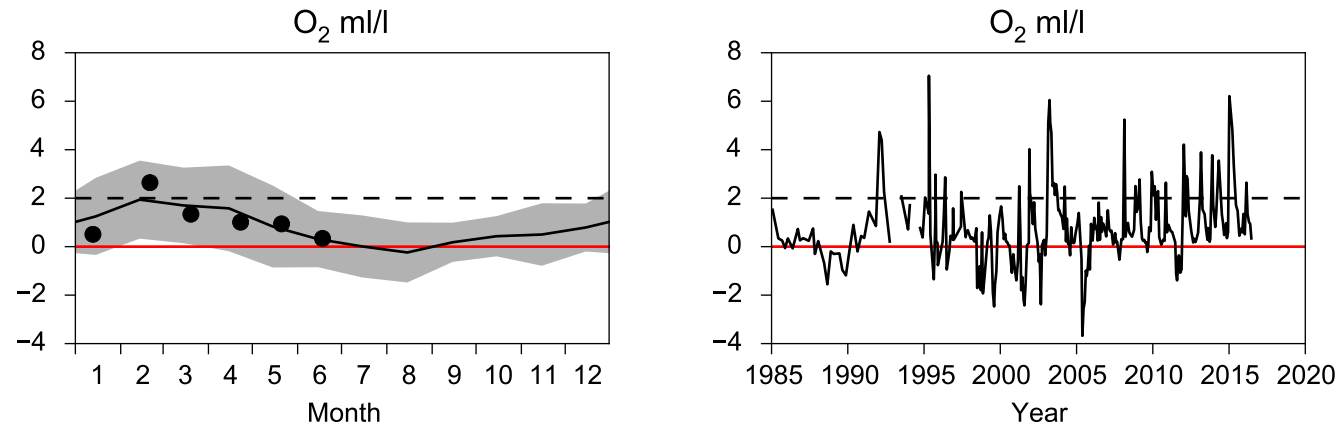


STATION HANÖBUKTEN SURFACE WATER (0-10m)

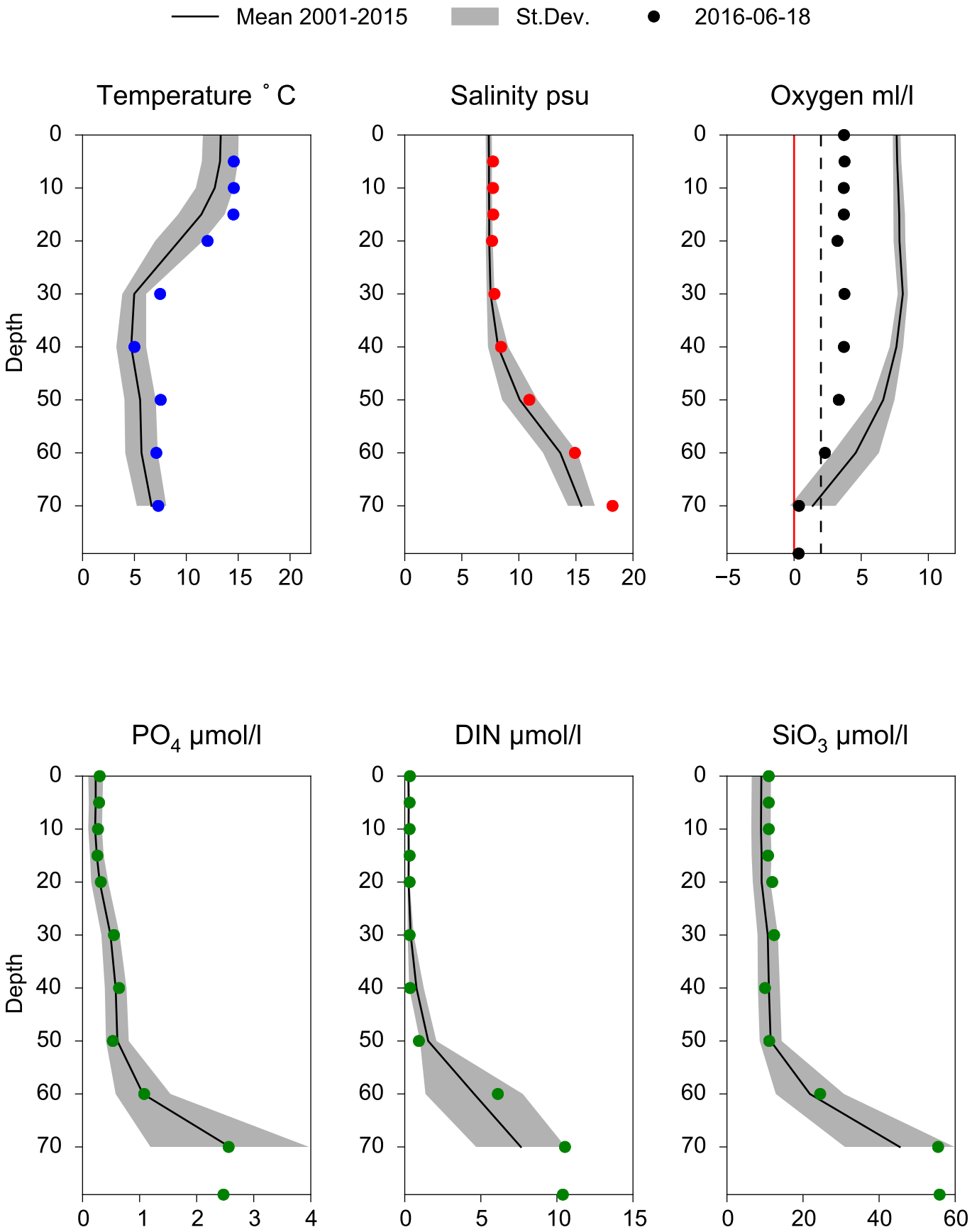
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 70 m)



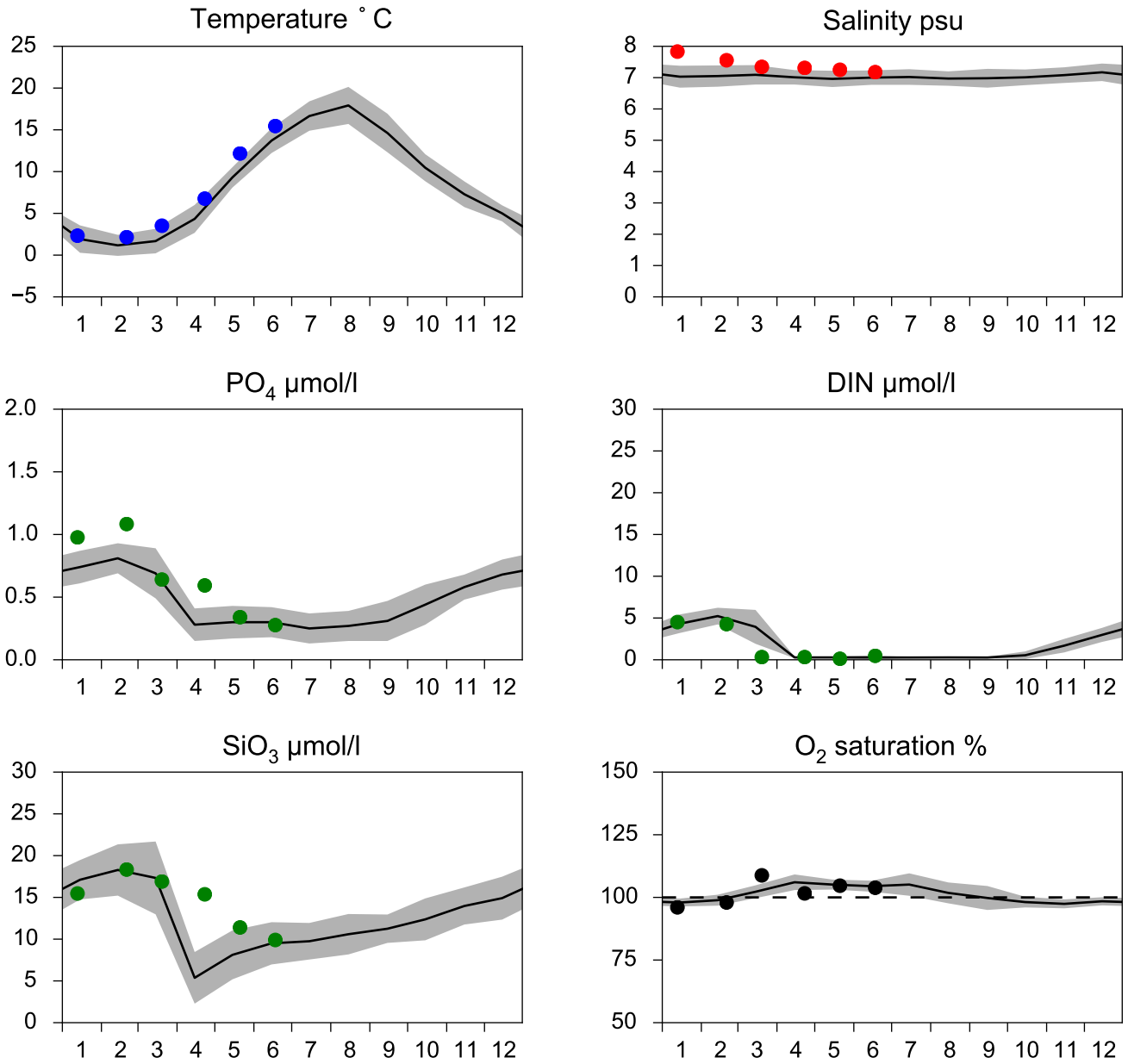
Vertical profiles HANÖBUKTEN
June



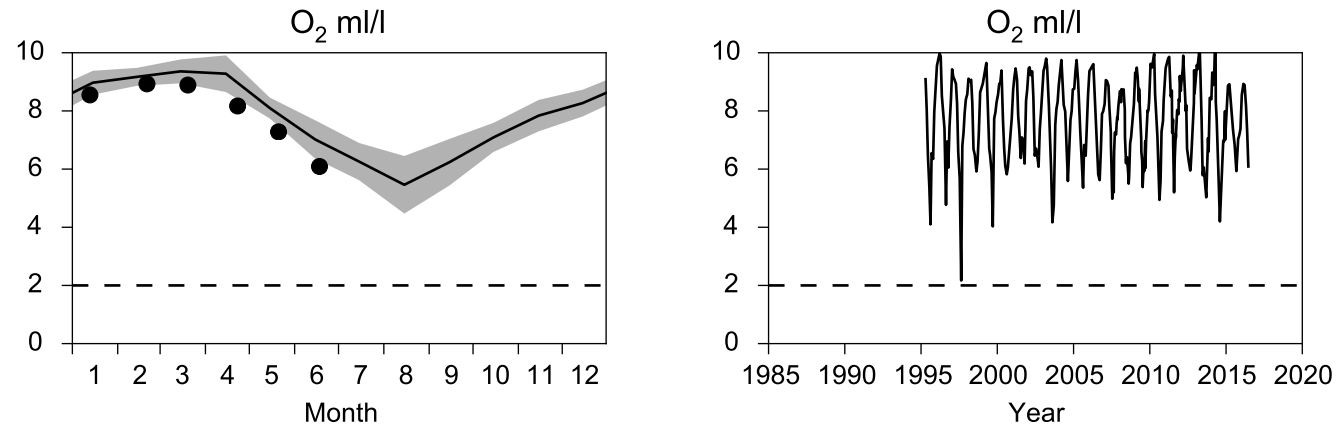
STATION REF M1V1 SURFACE WATER (0-10m)

Annual Cycles

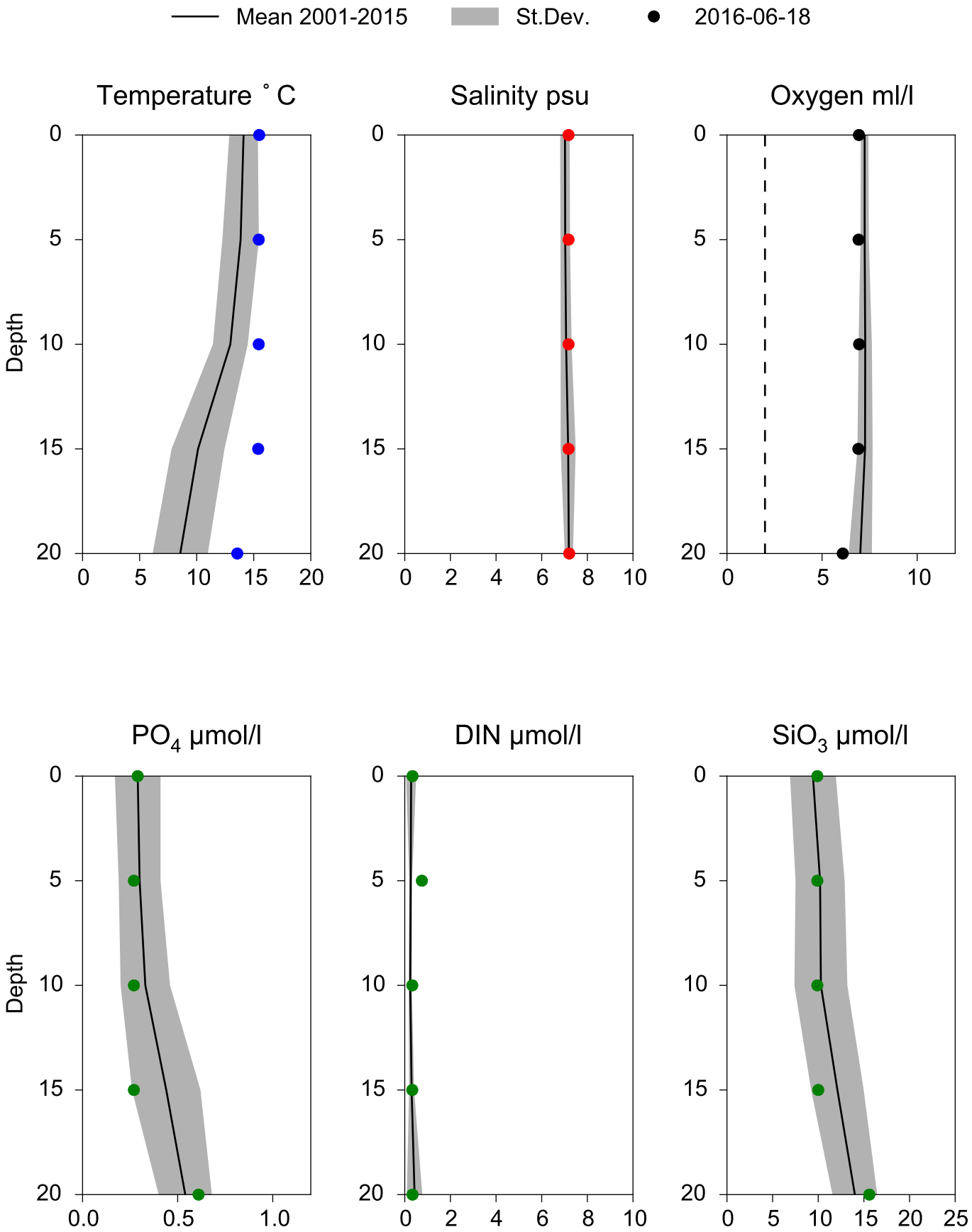
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 17 m)



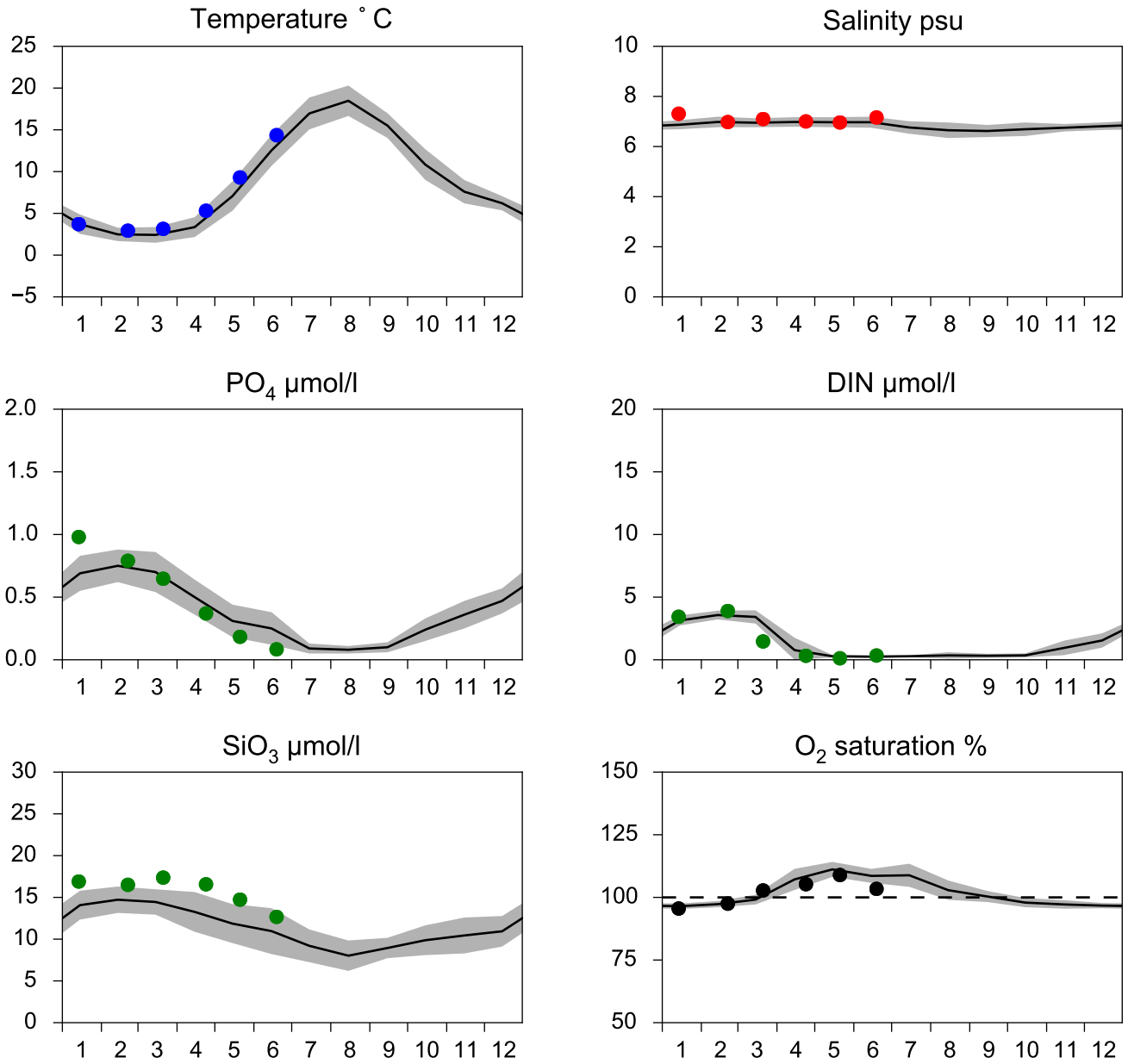
Vertical profiles REF M1V1
June



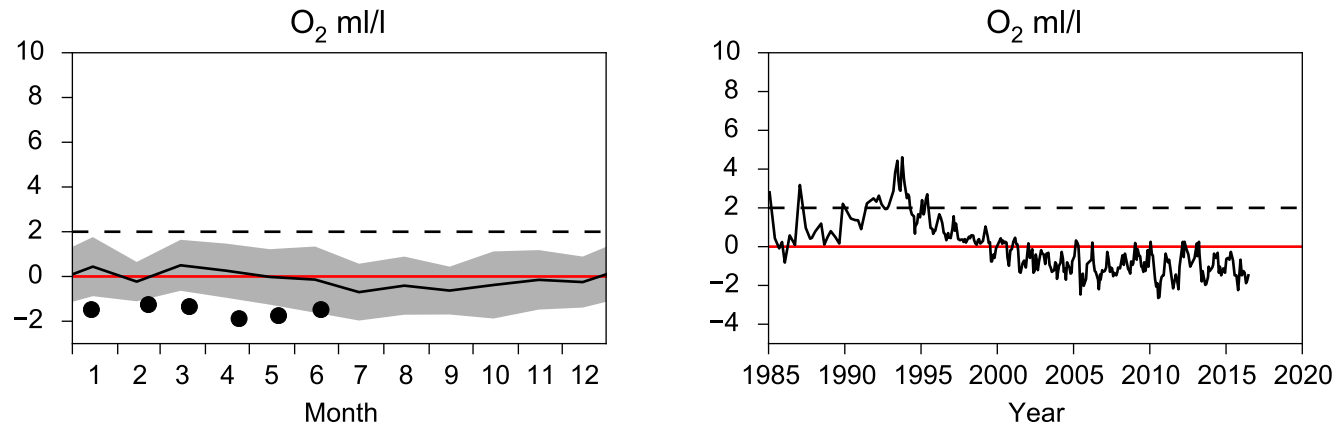
STATION BY38 KARLSÖDJ SURFACE WATER (0-10m)

Annual Cycles

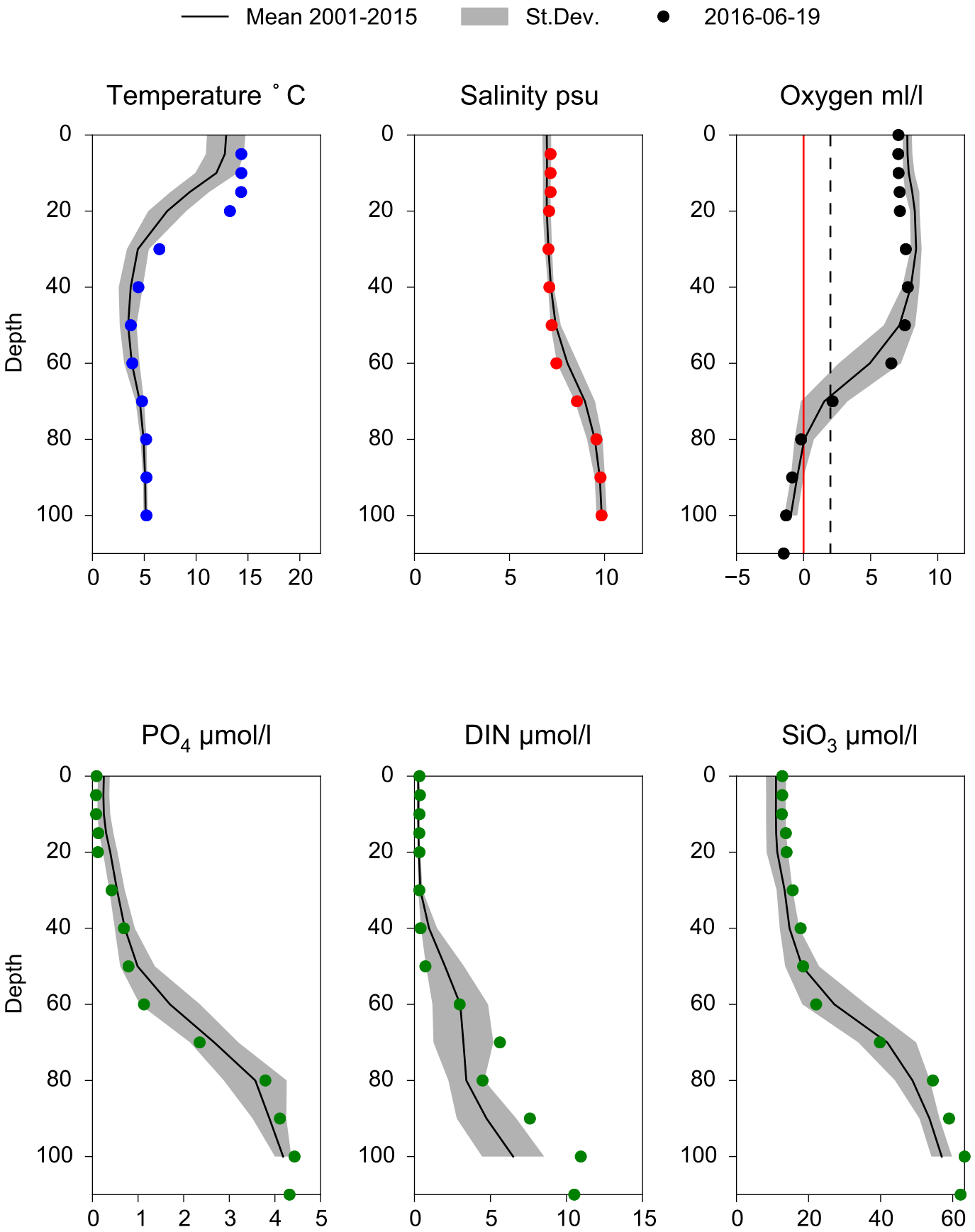
Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 100 m)



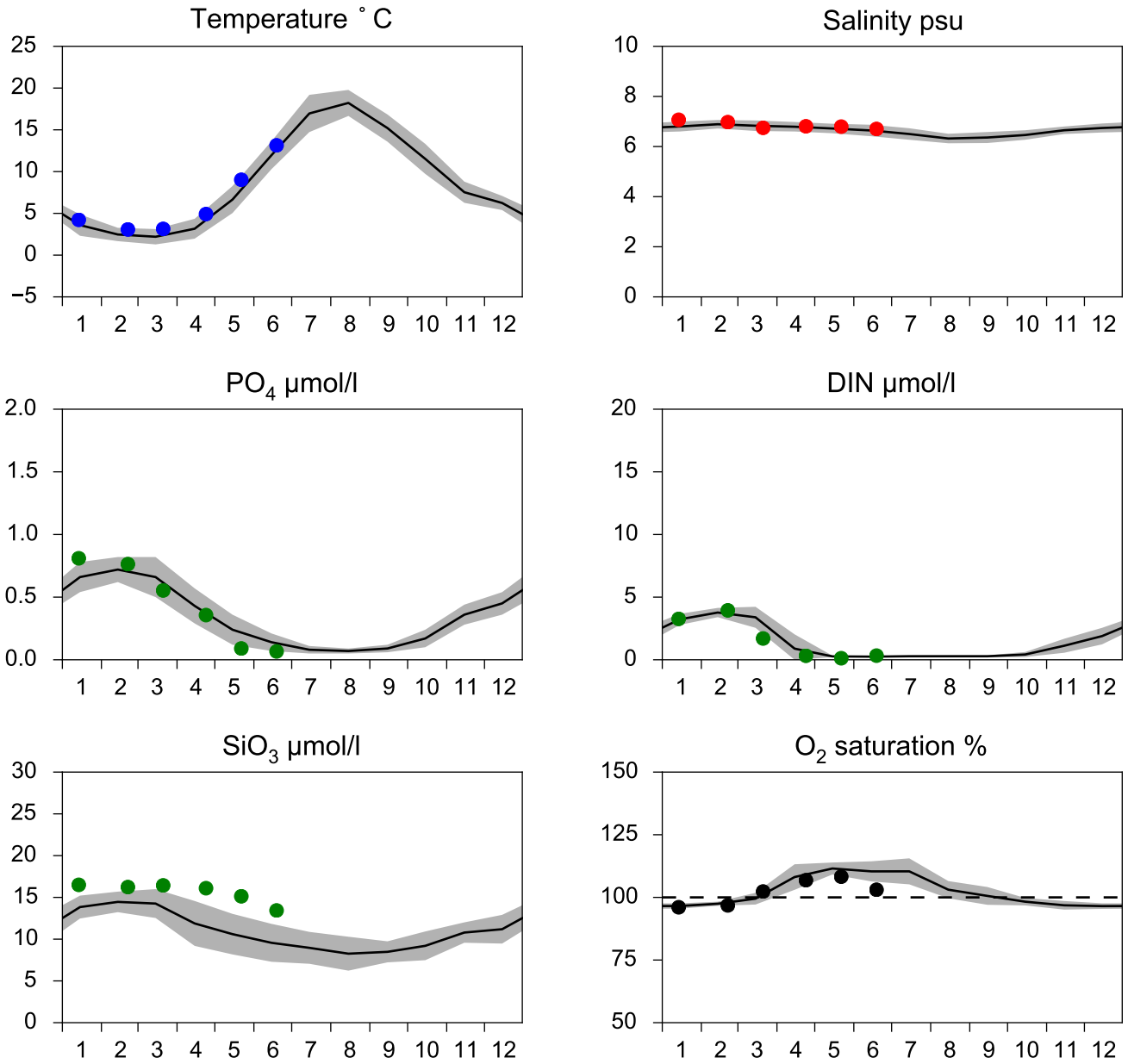
Vertical profiles BY38 KARLSÖDJ
June



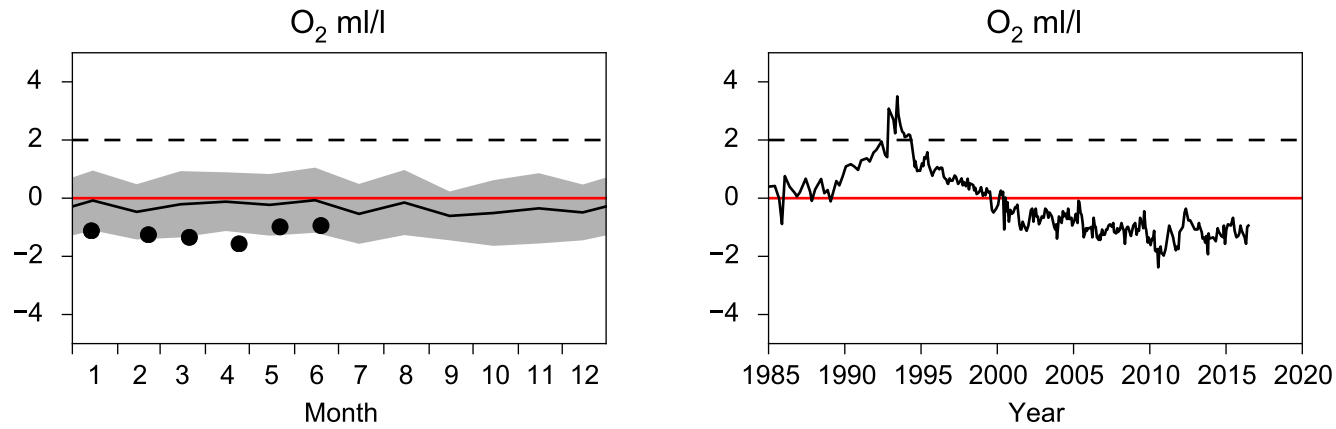
STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10m)

Annual Cycles

Mean 2001-2015 | St.Dev. | 2016



OXYGEN IN BOTTOM WATER (depth >= 175 m)



Vertical profiles BY32 NORRKÖPINGSDJ
June